10-16-00

A

EXPRESS MAIL LABEL NO. EM350826769US
Lyon & Lyon Docket No. 254/255

10/12/00 JC760 U.S. PTO

BOX PATENT APPLICATION
Commissioner for Patents
Washington, D. C. 20231

JC853 U.S. PTO 09/687759 10/12/00

Sir:

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is a utility patent application of:

Inventors: Scott HEMPHILL, Dr. James SHIGLEY, Dr. Ilene Reinitz, Dr. Mary L. Johnson

For: MODELING THE APPEARANCE OF THE ROUND BRILLIANT CUT DIAMOND; AN ANALYSIS OF FIRE AND SCINTILLATION

_X_ 29 pp. Spec.; 20 pp. claims; 1 p. abstract

_X_ 53 sheets of drawings (_X_ Informal __ Formal)

___ Declaration

___ Power of Attorney

___ Verified Statement Claiming Small Entity Status under 37 CFR §§ 1.9 and 1.27

___ Assignment of the invention to: ____________________.

_X_ This application is being filed without fee or Declaration under 37 CFR § 1.53.

_X_ I hereby certify Under 37 C.F.R. 1.10 that this paper (along with any referred to as being attached or enclosed) is being deposited with the United States Postal Service on October 12, 2000 with sufficient postage as "Express Mail Post Office to Addressee," having Express Mail Label No. EM350826769US in an envelope addressed to Box Patent Application, Commissioner for Patents, Washington, D.C. 20231.

09687759 .101200

LYON & LYON LLP

Dated: October 12, 2000

By: Brent D. Sokol
Brent D. Sokol
Reg. No. 38,621

633 West Fifth Street
Suite 4700
Los Angeles, CA 90071-2066
(213) 489-1600

LA-165191.1

SPECIFICATION

SYSTEMS AND METHODS FOR EVALUATING THE APPEARANCE OF A GEMSTONE

BACKGROUND OF THE INVENTION

The quality and value of faceted gem diamonds are often described in terms of the "four C's": carat weight, color, clarity, and cut. Weight is the most objective, because it is measured directly on a balance. Color and clarity are factors for which grading standards have been established by GIA, among others. Clamor for the standardization of cut, and calls for a simple cut grading system, have been heard sporadically over the last 27 years, gaining strength recently (Shor, 1993, 1997; Nestlebaum, 1996, 1997). Unlike color and clarity, for which diamond trading, consistent teaching, and laboratory practice have created a general consensus, there are a number of different systems for grading cut in round brilliants. As described in greater detail herein, these systems are based on relatively simple assumptions about the relationship between the proportions and appearance of the round brilliant diamond. Inherent in these systems is the premise that there is one set (or a narrow range) of preferred proportions for round brilliants, and that any deviation from this set of proportions diminishes the attractiveness of a diamond. However, no system described to date has adequately accounted for the rather complex relationship between cut proportions and two of the features within the canonical description of diamond appearance -- fire and scintillation.

Diamond manufacturing has undergone considerable change during the past century. For the most part, diamonds have been cut within very close proportion tolerances, both to save weight while maximizing appearance and to account for local market preferences (Caspi, 1997). Differences in proportions can produce noticeable differences in appearance in round-brilliant-cut diamonds. Within this single cutting style, there is substantial debate—and some strongly held views—about which proportions yield the best face-up appearance (Federman, 1997). Yet

face-up appearance depends as well on many intrinsic physical and optical properties of diamond as a material, and on the way these properties govern the paths of light through the faceted gemstone. (Other properties particular to each stone, such as polish quality, symmetry, and the presence of inclusions also effect the paths of light through the gemstone).

Diamond appearance is described chiefly in terms of brilliance (white light returned through the crown), fire (the visible extent of light dispersion into spectral colors), and scintillation (flashes of light reflected from the crown). Yet each of these terms cannot be expressed mathematically without making some assumptions and qualifications. Many aspects of diamond evaluation with respect to brilliance are described in "Modeling the Appearance of the Round Brilliant Cut Diamond: An Analysis of Brilliance." Gems & Gemology, Vol. 34, No. 3, pp. 158-183 (which is hereby incorporated by reference).

Several analyses of the round brilliant cut have been published, starting with Wade (1916). Best known are Tolkowsky's (1919) calculations of the proportions that he believed would optimize the appearance of the round-brilliant-cut diamond. However, Tolkowsky's calculations involved two-dimensional images as graphical and mathematical models. These were used to solve sets of relatively simple equations that described what was considered to be the brilliance of a polished round brilliant diamond. (Tolkowsky did include a simple analysis of fire, but it was not central to his model).

The issues raised by diamond cut are beneficially resolved by considering the complex combination of physical factors that influence the appearance of a faceted diamond (e.g., the interaction of light with diamond as a material, the shape of a given polished diamond, the quality of its surface polish, the type of light source, and the illumination and viewing conditions), and incorporating these into an analysis of that appearance.

Diamond faceting began in about the 1400s and progressed in stages toward the round brilliant we know today (see Tillander, 1966, 1995). In his early mathematical model of the behavior of light in fashioned diamonds, Tolkowsky (1919) used principles from geometric

optics to explore how light rays behave in a prism that has a high refractive index. He then applied these results to a two-dimensional model of a round brilliant with a knife-edge girdle, using a single refractive index (that is, only one color of light), and plotted the paths of some illustrative light rays.

Tolkowsky assumed that a light ray is either totally internally reflected or totally refracted out of the diamond, and he calculated the pavilion angle needed to internally reflect a ray of light entering the stone vertically through the table. He followed that ray to the other side of the pavilion and found that a shallower angle is needed there to achieve a second internal reflection. Since it is impossible to create substantially different angles on either side of the pavilion in a symmetrical round brilliant diamond, he next considered a ray that entered the table at a shallow angle. Ultimately, he chose a pavilion angle that permitted this ray to exit through a bezel facet at a high angle, claiming that such an exit direction would allow the dispersion of that ray to be seen clearly. Tolkowsky also used this limiting case of the ray that enters the table at a low angle and exits through the bezel to choose a table size that he claimed would allow the most fire. He concluded by proposing angles and proportions for a round brilliant that he believed best balanced the brilliance and fire of a polished diamond, and then he compared them to some cutting proportions that were typical at that time. However, since Tolkowsky only considered one refractive index, he could not verify the extent to which any of his rays would be dispersed. Nor did he calculate the light loss through the pavilion for rays that enter the diamond at high angles.

Over the next 80 years, other researchers familiar with this work produced their own analyses, with varying results. It is interesting (and somewhat surprising) to realize that despite the numerous possible combinations of proportions for a standard round brilliant, in many cases each researcher arrived at a single set of proportions that he concluded produced an appearance that was superior to all others. Currently, many gem grading laboratories and trade organizations

that issue cut grades use narrow ranges of proportions to classify cuts, including what they consider to be best.

Several cut researchers, but not Tolkowsky, used "Ideal" to describe their sets of proportions. Today, in addition to systems that incorporate "Ideal" in their names, many people use this term to refer to measurements similar to Tolkowsky's proportions, but with a somewhat larger table (which, at the same crown angle, yields a smaller crown height percentage). This is what we mean when we use "Ideal" herein.

Numerous standard light modeling programs have also been long available for modeling light refractive objects. E.g., Dadoun, et al., The Geometry of Beam Tracing, ACM Symposium on Computational Geometry, 1985, p. 55-61; Oliver Devillers, Tools to Study the Efficiency of Space Subdivision for Ray Tracing; Proceedings of PixIm '89 Conference; Pub. Gagalowicz, Paris; Heckbert, Beam Tracing Polygonal Objects, Ed. Computer Graphics, SIGGRAPH '84 Proceedings, Vol. 18, No. 3, p. 119-127; Shinya et al., Principles and Applications of Pencil Tracing, SIGGRAPH '87 Proceedings, Vol. 21, No. 4, p. 45-54; Analysis of Algorithm for Fast Ray Tracing Using Uniform Space Subdivision, Journal of Visual Computer, Vol. 4, No. 1, p. 65-83. However, regardless of what standard light modeling technique is used, the diamond modeling programs to date have failed to define effective metrics for diamond cut evaluation. See e.g., (Tognoni, 1990) (Astric et al., 192) (Lawrence, 1998) (Shor 1998). Consequently, there is a need for a computer modeling program that enables a user to make a cut grade using a meaningful diamond analysis metric. Previously, Dodson (1979) used a three-dimensional model of a fully faceted round brilliant diamond to devise metrics for brilliance, fire, and "sparkliness" (scintillation). His mathematical model employed a full sphere of approximately diffuse illumination centered on the diamond's table. His results were presented as graphs of brilliance, fire, and sparkliness for 120 proportion combinations. They show the complex interdependence of all three appearance aspects on pavilion angle, crown height, and table size. However, Dodson simplified his model calculations by tracing rays from few directions and of

few colors. He reduced the model output to one-dimensional data by using the reflection-spot technique of Rosch (S. Rosch, 1927, Zeitschrift Kristallographie, Vol. 65, pp. 46 – 48.), and then spinning that computed pattern and evaluating various aspects of the concentric circles that result. Spinning the data in this way greatly reduces the richness of information, adversely affecting the aptness of the metrics based on it. Thus, there is a need for diamond evaluation that comprises fire and scintillation analysis.

SUMMARY OF THE INVENTION

According to one embodiment described herein, a system models interaction of light with a faceted diamond and analyzes the effect of cut on appearance. To this end, computer graphics simulation techniques were used to develop the model presented here, in conjunction with several years of research on how to express mathematically the interaction of light with diamond and also the various appearance concepts (i.e., brilliance, fire, and scintillation). The model serves as an exemplary framework for examining cut issues; it includes mathematical representations of both the shape of a faceted diamond and the physical properties governing the movement of light within the diamond.

One mathematical model described herein uses computer graphics to examine the interaction of light with a standard (58 facet) round-brilliant-cut diamond with a fully faceted girdle. For any chosen set of proportions, the model can produce images and numerical results for an appearance concept (by way of a mathematical expression). To compare the appearance concepts of brilliance, fire, and scintillation in round brilliants of different proportions, we prefer a quantity to measure and a relative scale for each concept. A specific mathematical expression (with its built-in assumptions and qualifications) that aids the measurement and comparison of a concept such as fire is known as a metric. In one embodiment, the metric for fire considers the total number of colored pixels, color distribution of the pixels, length distribution of colored segments (as a function of angular position), density distribution of colored segments, angular

distribution of colored segments, the distribution of colors over both azimuthal and longitudinal angle, and/or the vector nature (directionality) of colored segments. A more preferred embodiment uses the following metric to evaluate fire: sum (over wavelength) of the sum (over the number of ray traces) of the differential area of each ray trace that exceeds a power density threshold cutoff, multiplied by the exit-angle weighting factor. This may be calculated as follows:

$$\mathrm{DCLR} = \Sigma_{\mathrm{wavelengths}}\, \Sigma_{\mathrm{rays}}\, (\mathrm{dArea} * \sigma * \mathrm{Weighting\ Factor}).$$

In this preferred embodiment, if the power density of a trace is greater than the threshold cutoff, $\sigma = 1$; otherwise $\sigma = 0$ and the ray (or other incident light element) is not summed. In a most preferred embodiment, comprising a point light source, the metric considers the total number of colored pixels (sum of rays), the length distribution of colored segments (because with a point source, length approximates differential area), angular distribution of colored segments (the weighting factor) and a threshold cutoff ($\sigma = 0$ or 1) for ray (or other incident light element) power density. Although other factors (e.g., bodycolor or inclusions) may also influence how much fire a particular diamond provides, dispersed-color light return (DCLR) is an important component of a diamond fire metric.

The systems and methods described herein may further be used to specifically evaluate how fire and scintillation are affected by cut proportions, including symmetry, lighting conditions, and other factors. In addition to the cut proportions expressly including in the tables, other proportions, such as crown height and pavilion depth may be derived from the tables, and used as the basis for optical evaluation and cut grade using the methods and systems disclosed herein. Other embodiments and applications include an apparatus and system to grade a faceted diamonds, new methods of providing target proportions for cutting diamonds, new types of diamonds cuts and new methods for cutting diamonds.

Within the mathematical model, all of the factors considered important to diamond appearance—the diamond itself, its proportions and facet arrangement, and the lighting and

observation conditions—can be carefully controlled, and fixed for a given set of analyses. However, such control is nearly impossible to achieve with actual diamonds. The preferred model described herein also enables a user to examine thousands of sets of diamond proportions that would not be economically feasible to create from diamond rough. Thus, use of the model allows the user to determine how cut proportions affect diamond appearance in a more comprehensive way than would be possible through observation of actual diamonds. In one preferred embodiment, the system, method and computer programs use to model the optical response of a gemstone use Hammersley numbers to choose the direction and color for each element of light refracted into a model gemstone (which defines the gemstone facets) to be eventually reflected by the model gemstone's virtual facets, and eventually exited from the model gemstone to be measured by a model light detector. The gemstone is then ultimately graded for its optical properties based on the measurement of said exited light elements from the gemstone model.

In another preferred embodiment, the system determines the grade of a cut using certain assumptions—best brilliance, best fire, best balance of the two, best scintillation, best weight retention, best combination—that can be achieved from a particular piece of rough. In addition, an instrument may also measure optical performance in real diamonds based on the models described. The models of light diamond interaction disclosed herein can also be used to compare and contrast different metrics and different lighting and observation conditions, as well as evaluate the dependence of those metrics on proportions, symmetry, or any other property of diamond included in the model.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a drawing and table that outlines the assumptions on which a preferred model is based. Diamond model reference proportions in this patent application, unless otherwise

specified, are table 56%, crown angle 34°, pavilion angle 40.5°, girdle facet 64, girdle thickness 3.0%, star facet length 50%, lower girdle length 75%, culet size .5%.

Figure 2 is a plot of DCLR versus crown angle over three thresholds for a modeled round brilliant diamond along with the table of corresponding data.

Figure 3 is a plot of DCLR versus pavilion angle over three thresholds for a modeled round brilliant diamond along with the table of corresponding data.

Figure 4 is a plot and table of DCLR with reference to crown angle and table size for a low power density threshold cutoff modeling system.

Figure 5 is a plot and table of DCLR with reference to crown angle and table size for a medium power density threshold cutoff modeling system.

Figure 6 is a plot and table of DCLR with reference to crown angle and table size for a high power density threshold cutoff modeling system.

Figure 7 is a table of DCLR rating for various diamond proportions, varying by star facet length, for 3 values of crown angle.

Figure 8 is a table of DCLR ratings for various diamond proportions, varying by star facet length, for a medium power density threshold cutoff modeling system.

Figure 9 is a table of DCLR ratings for various diamond proportions, varying by star facet length, for a low power density threshold cutoff modeling system.

Figure 10 is a table of DCLR ratings for various diamond proportions, varied by pavilion angle and table size, for a high power density threshold cutoff modeling system.

Figure 11 is a table of DCLR ratings for various diamond proportions, varied by pavilion angle and table size, for a medium power density threshold cutoff modeling system.

Figure 12 is a table of DCLR ratings for various diamond proportions, varied by pavilion angle and table size, for a low power density threshold cutoff modeling system.

Figure 13 is a diagram of one fourth of the view from infinity of the totally dispersed light for a diamond of 33.5° crown angle, 4.0° pavilion angle, and table .55 with 64 girdle facets, a 3% girdle thickness, a 50% star facet length, 75% lower-girdle length and a .5% culet size.

Figure 14 is a diagram of one fourth of the view from infinity of the totally dispersed light for a diamond of 31.5° crown angle, 38.7° pavilion angle, and table .52 with 64 girdle facets, a 3% girdle thickness, a 50% star facet length, 75% lower-girdle length and a .5% culet size.

Figure 15 is a diagram of one fourth of the view from infinity of the totally dispersed light for a diamond of 31.5° crown angle, 40.7° pavilion angle, and table .52 with 64 girdle facets, a 3% girdle thickness, a 50% star facet length, 75% lower-girdle length and a .5% culet size.

Figure 16 is a diagram of one fourth of the view from infinity of the totally dispersed light for a diamond of 31.5° crown angle, 42.7° pavilion angle, and table .52 with 64 girdle facets, a 3% girdle thickness, a 50% star facet length, 75% lower-girdle length and a .5% culet size.

Figure 17 is a diagram of one fourth of the view from infinity of the totally dispersed light for a diamond 33.5° crown angle, 40.7° pavilion angle, and table .60 with 64 girdle facets, a 3% girdle thickness, a 50% star facet length, 75% lower-girdle length and a .5% culet size.

Figure 18 is a diagram of one fourth of the view from infinity of the totally dispersed light for a diamond 35.3° crown angle, 40.0° pavilion angle, and table .56 with 64 girdle facets, a 3% girdle thickness, a 50% star facet length, 75% lower-girdle length and a .5% culet size.

Figure 19 is a diagram of one fourth of the view from infinity of the totally dispersed light for a diamond 28.5° crown angle, 40.7° pavilion angle, and table .53 with 64 girdle facets, a 3% girdle thickness, a 50% star facet length, 75% lower-girdle length and a .5% culet size.

Figure 20 is a diagram of one fourth of the view from infinity of the totally dispersed light for a diamond 28.5°, crown angle, 40.7° pavilion angle, and table .63 with 64 girdle facets, a 3% girdle thickness, a 50% star facet length, 75% lower-girdle length and a .5% culet size.

Figure 21 is a diagram of one fourth of the view from infinity of the totally dispersed light for a diamond 34.5°, crown angle, 40.7° pavilion angle, and table .57 with 64 girdle facets, a 3% girdle thickness, a 50% star facet length, 75% lower-girdle length and a .5% culet size.

Figure 22 is a diagram of one fourth of the view from infinity of the totally dispersed light for a diamond 32.7°, crown angle, 41.5° pavilion angle, and table .60 with 64 girdle facets, a 3% girdle thickness, a 50% star facet length, 75% lower-girdle length and a .5% culet size.

Figure 23 is a table of DCLR rating for certain diamond proportions, varying by table size.

Figure 24 is a table of DCLR rating for certain diamond proportions, varying by lower girdle size.

Figure 25 is a plot of DCLR versus culet size corresponding to Figure 26.

Figure 26 is a table of DCLR rating for certain diamond proportions, varying by culet size.

DESCRIPTION OF THE INVENTION

<u>Assumptions and Methods</u>. The mathematical model presented here creates a fresh structure for examining nearly all aspects of the influence that cut has on a diamond's appearance. Fig. 1 provides the assumptions on which a preferred model may be based: a detailed list of the physical properties included in the model, a mathematical description of the proportions of the round brilliant, and a description of the lighting condition used in this study. The details of the lighting conditions affect the specific numerical values we present here. The model traces light from the modeled light source through a mathematical representation of a round brilliant of any chosen proportions (referred to hereafter as the "virtual" diamond) to

produce two kinds of results: (1) digital images of the virtual diamond, and (2) a numerical evaluation of an appearance concept (in this case, fire).

The metrics disclosed herein may be run on any computer, such as a Pentium-based PC using standard light refraction modeling techniques and light elements, including those used in CAD Programs, as are known in the art.

The preferred metric for fire, Dispersed Colored Light Return (DCLR), is an original product the development of which required considerable creative thought. DCLR describes the maximum extent to which a given set of proportions can disperse light toward an observer; the value is defined using a point light source at infinite distance and a hemispherical observer also located at infinity. (In general, observed dispersion depends strongly on the light source and observation geometry: as the distance between the observer and diamond increases, the observer sees less white light and more dispersed colors).

Another metric, describing scintillation, may consider both the static view (amount and degree of contrast) and the dynamic view (how the contrast pattern changes with movement), and may factor in parts of brilliance (how the spatial resolution of the contrast interacts with human vision to affect how "bright" an object looks, and the effects of glare), and describe what most diamond cutters call "life," and Dodson (1979) calls "sparkliness." The relevant scintillation factors for the static view include the number of edges seen across the face of the round brilliant, the distribution of distances between those edges, the shapes made by them, the contrast in output power across those edges (e.g. black against white or medium gray against pale gray), and the visual impact of colored rays on the appearance of the black and white pattern. All these aspects are present in the "view-from infinity" (VFI) diagrams of the model output; See Figs. 13-22, however, they are also discernable in a head-on photo or direct observation of a diamond. The relationship between the positions of exit rays at infinity and the shapes they form on an image plane above the stone (parallel to the table) at some distance, enables a user of the model to calculate a scintillation metric from the raw data at any chosen distance. The factors listed

above change in numerical value with differences in vertical distance. Thus, the metric may be based on a vertical distance or distances suitable to approximate the experience of a standard observer.

The metrics for fire and scintillation may also incorporate dynamic aspects. Dynamic aspects into the preferred fire metric, DCLR, are obtained by placing the observer at infinity and weighting the contributions of rays by their exit angle with a cosine-squared function. Another way to explore dynamic shifts is to move the light source – such that the incoming rays are perpendicular to a bezel or star facet rather than the table, and compare the output (both the diagram and DCLR value) to that obtained with the light source directly over the table. The dynamic aspects of scintillation likewise involve changes in the black-and-white pattern with motion of the stone, light source, or observer.

The details of human vision may also be incorporated in each of these metrics. Thus, DCLR preferably incorporates a threshold for the amplitude range of human vision with "ordinary" background illumination. (Humans see considerably more than the 256 levels of gray used by a computer monitor). The scintillation metric incorporates human vision aspects related to contrast intensity and spatial resolution of contrasting light levels and colors and considers how colored rays look against different patterns. These aspects of human vision also come into play in the design of a human observation exercise, wherein a number of people will observe a fixed set of diamonds under one or more fixed viewing conditions, and compare their brilliance, brightness, fire, and scintillation, as a check on the predictions from modeling.

Although the human visual system can detect as few as 7 photons when it is fully adapted to the dark, far more light is required to stimulate a response in an ordinarily bright room. The specific range of the human visual system in ordinary light has not been definitively measured, but professional estimates suggest detection of up to 10,000 gray levels. (A computer monitor uses 256 levels, and high-quality photographic film has just under 1000). Thus it is uncertain how much of fire to take into consideration to match the capacity of human vision: Accordingly,

one embodiment of the metric comprises a threshold power density cutoff to approximate human vision. Furthermore, the power density threshold may be weighted to account for differentiation in human eye sensitivity to different parts of visual spectrum (e.g., use a higher threshold cutoff for green light because humans have lower sensitivity for green as compared to blue light). This principle also applies with force to the scintillation metric. As disclosed herein, DCLR values may be calculated using ranges of 2, 3, and 4 orders of magnitude (i.e. including rays down to 100 (fire 2), 1000 (fire 3), and 10,000 (fire 4) times weaker than the brightest ones). In the preferred embodiment, DCLR is a directly computed value, and traces all light from the source so there is no convergence and no error. The results are shown as DCLR values graphed against various proportion parameters. See Figs. 2-6. Fire 2 means that a threshold eliminates refracted light elements at less than 1% of the brightest light elements. Fire 3 uses a cut off of .1% off and Fire 4 uses a .01% cut off. The obvious result from this initial data is that DCLR (and thus fire) does not have a monotonic dependence on only the crown proportions, as Tolkowsky's 1919 work claimed, but shows a multi-valued dependence on several proportions, including the pavilion angle. In other words, DCLR, like WLR, can be maximized in a number of ways.

Different lighting geometries emphasize different aspects of a diamond's appearance. Thus, although the lighting and observing conditions must be specified for a given metric, these conditions can be varied and used in calculation of similar metrics.

Likewise, in a preferred embodiment, the model assumes a fully faceted girdle, perfect symmetry, perfect polish, no color, no fluorescence, no inclusions, and no strain. Actual diamonds may have bruted girdles, asymmetries (e.g. culet off center, or table not parallel to girdle), scratches and polishing lines, color, blue or yellow fluorescence of varying strengths, a variety of inclusions, and a strain in a variety of distributions. Each of these properties affects the movement of light and the actual expression of the appearance aspects. Many of these aspects may be incorporated into the model. In another embodiment, the invention contemplates

the use of a device (or devices, one for each metric) that measures the various appearance metrics for actual diamonds, including each one's particular oddities.

Although the DCLR may be calculated for the idealized set of average proportions, they may also be calculated for that of a particular stone. Thus, in another embodiment, a low end grade may be used for the diamond industry and jewelers; the metrics disclosed herein readily identify sets of proportions with poor optical performance. See Figs. 2-6.

Defining Metrics: FIRE.

One advantage of using a computer model is the capability it gives us to examine thousands of proportion variations. To make sense of so much data, however, we needed to define a metric for fire, and use it to compare the performance of the different proportion combinations. A variety of mathematical expressions can be created to describe such light. Each expression requires explicit or implicit assumptions about what constitutes fire and about light sources, viewing geometry, response of the human eye, and response of the human brain. The mathematical definition of fire may represent one viewing geometry—that is, a "snapshot"—or, more preferably, represent an average over many viewing situations.

Dispersed-Colored Light Return. A preferred metric described herein is called Dispersed Colored Light Return (DCLR); it is specific to each set of modeled diamond proportions with the chosen illumination. After examining a variety of possible metrics for fire, DCLR represents the best way to evaluate fire using a viewing model that looks at the stone from an infinite distance to achieve maximum dispersion.

According to this preferred embodiment, the metric for fire, DCLR, uses an approach that is completely different than the approach Dodson (1979) used. Starting with a point light source at infinity and a hemispherical observer, also at infinity, the preferred metric takes into account the size, brightness, exit angle, number and color of all incident light elements that exit the crown using the following equation:

$$\mathrm{DCLR} = \Sigma_{\text{wavelengths}}\, \Sigma_{\text{light elements}}\, (\text{dArea} * \text{Weighting Factor}).$$

In a more preferred embodiment, the method uses the same weighting factor, the square of the cosine of the exit angle, as in the Weighted Light Return Model discussed in Gems and Gemology Vol. 34, No. 3. pp. 158-183, Fall 1998 (e.g. rays that exit the modeled diamond vertically (90%) have a weighting factor of 1, and rays that exit at 65° have a weighting factor of 0.82). This weighting numerically mimics the common industry practice of rocking a stone back and forth and from side to side while observing it, through an angular sweep of about 35 - 40% from the vertical. The light elements may be pencils, bundles, rays or any other light unit element known in the light modeling art.

The light elements to be included in DCLR may be also required to meet a power density threshold cutoff. Thus, in a most preferred embodiment, the DCLR is a sum (over wavelength) of the sum (over the number of light element traces) of the differential area of each light element trace that surpasses a threshold power density cutoff (most preferably 1% of the brightest element) times an exit-angle weighting factor.

The most preferred embodiment may beneficially trace pencils of light forward through the gemstone model and then trace rays backwards through the model to measure the optical properties of a gemstone. Each of the gemstone illumination models used herein may also include the use of Hammersley numbers to determine the direction and color for each light element directed at the gemstone model.

Dodson (1979) evaluated his metrics for 3 crown heights (10, 15, and 20%), 4 table sizes (40, 50, 60, and 70%), and 10 pavilion angles between 38 and 55%, a total of 120 proportion combinations, and showed that his three metrics yielded wide variations across these proportions. In contrast, the present description includes a calculated DCLR for 2148 combinations of 6 proportions: crown angle, pavilion angle, table size, star facet length, lower girdle length, and culet size. (This range includes both common commercial proportions and values of crown angles and star facet lengths that are very rarely cut). See Fig. 7-12. These metrics are computed functions of the 8 independent shape variables, and each data set forms a surface over the 6 shape

variables we have varied to date. We have explored the topography of the DCLR surface with standard graphical and numerical techniques, to find all those combinations that yield high DCLR, and to reveal relationships between proportions and brightness.

Moreover, using previously published WLR data, a user can also compare the DCLR data set with the previously described Weighted Light Return set (see Gem & Gemology Vol. 34, No. 3, pp. 158-183) or other brilliance data to find proportions that yield an attractive balance of brilliance and fire.

Results

In the preferred model, a point light source at infinite distance shines on the table of a virtual diamond of chosen proportions; because the light source is so far away all the entering rays are parallel. These rays refract and reflect, and all those that refract out of the crown fall on the observer, a hemisphere at infinite distance. Because the observer is so far away, all the light that falls on it is fully dispersed; thus, there is no "white" output. DCLR results are shown in Figs. 2-12. The VFI diagrams are direct output resulting from the model, with the background color reversed from black to white for greater ease in viewing and printing. See Fig. 13-22. A VFI diagram is one fourth of the observer hemisphere, unrolled onto the page or screen; the point is the overhead center of the hemisphere (light exiting perpendicular to the table, and the rounded border is the edge of the hemisphere (light exiting parallel to the girdle).

All static aspects of fire and scintillation are contained within this output. However, of the qualities we considered relevant to fire; only 3 of those 7 ended up in the most preferred metric (total number, length distribution [changed to differential area], and angular distribution) and we added a new concept, that of the threshold for power density. That concept comes from making the VFI diagrams because the number of colored segments changed so noticeably as a function of power density.

Images and DCLR. The calculations made with our model also may be used to produce realistic digital images of virtual diamonds. Thus, computer-generated images can reproduce the

patterns of light and dark seen in actual round brilliant diamonds under lighting conditions similar to those used with the model. The model can generate a variety of digital images, from different perspectives and with different lighting conditions. However, the details of how fire changes with proportions can be better studied by comparing a metric, such as DCLR values, than by visually examining thousands of images, whether VFI diagrams or virtual diamonds themselves.

Results for Key Individual Parameters. Our investigation of the dependence of DCLR on crown angle, pavilion angle, star facet length, and table size, began with an examination of how DCLR varies with each of these three parameters while the remaining seven parameters are held constant. Except where otherwise noted, we fixed these parameters at the reference proportions (see fig.1). See Figs. 7-12.

Crown Angle. In general, DCLR increases as crown angle increases; but, as Figure 2 shows, there are two local maxima in DCLR across the range of angles, at about 25° and 34-35°, and a rise in values at crown angles greater than 41°. However, moderately high crown angles of 36-40° yield a lower DCLR value than either of the local maxima. The same topography is seen at each of the three thresholds, although the numerical range of each data set (the difference between the maximum and minimum values) decreases as the threshold is raised.

Pavilion Angle. This is often cited by diamond manufacturers as the parameter that matters most in terms of brilliance (e.g., G. Kaplan, pers. comm., 1998), but we surprisingly found the greatest variation in DCLR for changes in pavilion angle. Figure 3 shows an overall decrease in DCLR (calculated with the lowest threshold) with increasing pavilion angle, with a true maximum at 38.75°, and local maxima at 40-41° and 42.25°. Unlike crown angle, pavilion angles are typically manufactured in a fairly narrow range; the peak from 40-41° covers a broad range for this parameter. Similar topography is seen for the intermediate threshold, but the peak at low pavilion angle is absent from DCLR calculated at the highest threshold.

Star Facet Length. We calculated the variation of DCLR (with the lowest threshold) with changes in the length of the star facet for three values of the crown angle: 34°, 36°, and 25°. The range in DCLR values is relatively small, but as seen in Figs. 7, 8, and 9 there is a primary maximum in each array. At the reference crown angle of 34°, a star facet length of .56 yields the highest DCLR. This maximum shifts to about .58 for a crown angle of 36°, and increases substantially to a star facet length of .65-.65 for a crown angle of 25°. Longer star facet length means that the star facet is inclined at a steeper angle relative to the table (and girdle, in a symmetrical round brilliant), and thus these results imply that the star facets act similarly to the bezel facets with regard to the production of fire. Also, as with crown angle, similar topography is seen in the arrays calculated with higher thresholds but with significantly reduced range of DCLR values.

Two of the high-threshold arrays (34° and 36° crown angle) and the medium-threshold data show secondary maxima at star facet lengths of .3, .32 and .36 respectively. Neither such short stars, nor the longer stars indicated by the primary maxima, are commonly used in the production of round brilliant diamonds.

Table Size. DCLR shows a bi-modal response to variations in table size, as shown in Figs. 10, 11, and 12. For the low and medium thresholds, DCLR is approximately constant for tables less than .55, rapidly decreases for tables of .56 and .57, and then remains approximately constant for tables of .58 and greater. For the highest threshold, DCLR is approximately constant across the entire range of table sizes. See, e.g., Fig. 23.

Lower Girdle. The variation of DCLR with lower girdle facet length is moderate, similar in magnitude to the variation found with crown angle. For all three thresholds, longer lower girdle facets are favored, with broad maxima at .80 - .85. Lower girdle facets form an angle with the girdle plane that is less than the pavilion angle; the longer these facets are the closer their angle becomes to the pavilion angle. See Fig. 24.

Culet Size. Unlike WLR, which showed little dependence on culet size, DCLR decreases significantly with increasing culet size. This decrease is smooth and monotonic, and for the lowest threshold the DCLR value decreases by 25%. See Figs. 25-26.

Thus, as shown in the tables and figures disclosed herein, a cut grade that considers fire can be made by reference to enter star facet length, lower girdle length, and culet size. For example, as shown in Figs. 2-6, the cut grade may be based on a fire peak within 40-41° pavilion angle, but also recognize fire peaks substantially at 38.75° and 42.5°.

Combined Effects. Some of the interactions between crown angle, pavilion angle, and table size—and their combined effects on DCLR values—can be seen when these proportion parameters are examined two at a time. One way to visualize these effects is to draw them to look like a topographic map (which shows the differences in elevation of an area of land). We can draw subsets of the data as cross-sections (slices) through the data set with one parameter held constant, and the WLR values can then be expressed as contours. These cross-sections can be read in the same manner as topographic maps; but instead of mountains, these "peaks" show proportion combinations that produce the highest calculated DCLR values.

Figure 4 shows such a contour map for DCLR (calculated with the lowest threshold) with variation in both crown angle and table size. Two "ridges" of rapidly varying DCLR values are evident at crown angles of 25-26° and crown angles greater than or equal to 34°. This latter ridge is broad and shows convoluted topography. These ridges become gullies with decreasing table size; that is, at these crown angles, table sizes of .58 and less yield high DCLR values, but larger table sizes yield lower DCLR values than are found at other crown angles. In particular, there is a local maximum in DCLR for tables of .65-.63 and a crown angle of 29°.

Somewhat similar topography is observed in Figs. 5 and 6, contour maps of DCLR over crown angle and table size for the medium and high thresholds, respectively. At the medium threshold, crown angles of 37-38° yield significantly lower DCLR at all table sizes greater than .57, while crown angles of 32-33° yield moderate DCLR across the whole range of table sizes.

There is a large ridge across shallow crown angles and all table sizes in the plot for the highest threshold, although for this data the numerical range of the values is quite small.

Figures 10, 11 and 12 give the data for variation in DCLR as pavilion angle and table size each vary, for the three thresholds. The topography becomes much more complex as the threshold is lowered, and the range of values increases considerably. For the lowest threshold, there is a small ridge at a pavilion angle of 38.25 and table sizes of .56 and lower, and for all three thresholds there is a long ridge at a pavilion angle of 39.25 across the whole range of table sizes. This ridge appears more broad at the highest threshold, covering pavilion angles from 39-41°.

Importantly, the Figures 4-6 and 10-12 demonstrate that preferred "fire" proportions based on the disclosed proportion parameters can serve as guides or even ranges in a cut grade determination.

Using DCLR Data to Evaluate Fire. The DCLR surfaces that we have calculated as a function of crown angle, pavilion angle, and table size are irregular, with a number of maxima, rather than a single maximum. These multiple "peaks" are a principal result of this extensive three-dimensional analysis. Their existence supports a position taken by many in the trade in terms of dispersed light return, or fire there are many combinations of parameters that yield equally "attractive" round brilliant diamonds. Neither the internal dispersion of light nor the interaction between the proportion parameters is taken into account by existing cut-grading systems, which are based on Tolkowsky's analysis at a single refractive index, and examine each parameter separately.

It is especially important to note that some proportion combinations that yield high DCLR values are separated from one another and not contiguous, as shown in the cross-sections of the DCLR surfaces. Thus, for some given values of two proportions, changes in the third proportion in a single direction may first worsen DCLR and then improve it again. This variation in DCLR with different proportion combinations makes the characterization of the

"best" diamonds, in terms of fire, a great challenge. Even for one simple shape—the round brilliant cut—and variation of only two proportion parameters at a time, the surfaces of constant DCLR are highly complex.

The specific proportion combinations that produce high DCLR values have a variety of implications for diamond manufacturing. Because many combinations of proportions yield similarly high DCLR values, diamonds can be cut to many choices of proportions with the same fire, which suggests a better utilization of rough.

Evaluation of "Superior" Proportions Suggested by Earlier Researchers. A gem diamond should display an optimal combination of brilliance, fire, and pleasing scintillation. Many previous researchers have suggested proportions that they claim achieve this aim, but none but Dodson have proposed a measure or test to compare the fire or scintillation of two sets of proportions. A list of "superior" proportions and their calculated WLR value was presented in Hemphill et al. (1998), and we have calculated DCLR for some of these proportions as well. The highest value we found was for Suzuki's Dispersion Design (1970), with a DCLR (at the lowest threshold, as are all the values presented in this discussion) of 6.94; however this set of proportions had yielded a very low WLR value of 0.205. Eppler's Ideal Type II proportions yielded a relatively high DCLR value of 5.04, and a moderately high WLR value of 0.281. Dodson's suggestion for most fiery was bright (WLR = 0.287) but yielded a low DCLR of 4.32. Dodson's proportions for the most sparkliness yielded a higher DCLR of 5.18, but with a low WLR value of 0.247. His suggestion for brightest had yielded an average WLR of 0.277, and a moderately low DCLR of 4.51.

Work by Shannon and Wilson, as described in the trade press (Shor, 1998), presented four sets of proportions that they claimed gave "outstanding performance" in terms of their appearance. Previously we calculated typical to moderately high WLR values for these proportions, and now we find moderate to moderately high DCLR values of 4.63 – 5.24.In comparison, Rosch's suggestion for "Ideal" proportions had yielded a low WLR value of 0.251,

but produce high DCLR of 5.94. Tolkowsky's suggested proportions, including the knife-edge girdle and a 53% table, yield a DCLR value of 5.58, but this value is reduced significantly as the table size or girdle thickness increases.

Implications for Existing Cut-Grading Systems. Our results disagree with the concepts on which the proportion grading systems currently in use by various laboratories appear to be based. In particular, they do not support the idea that all deviations from a narrow range of crown angles and table sizes should be given a lower grade. Nor do they support the premises that crown proportions matter most for fire.

Arguments that have been made for downgrading diamonds with lower crown angles or larger tables on the basis that they do not yield enough fire are in part refuted by the results of our modeling. Our results show more agreement with those of Dodson (1979): that fire depends on combinations of proportions, rather than on any single parameter. However, our results are at a finer scale than those of Dodson, and show distinct trends for certain ranges of proportion combinations.

References

Astric B., Merigoux H., Zecchini P. (1992) Etude de la variation de l'aspect de pierres taillées à l'aide d'images de synthèse. La Gemmologia, Vol. 17, No. 1, pp. 7–31.

Bergheimer H. (1938) Die Schleifrichtungen auf den Facetten des Diamantbrillanten. Neues Jahrbuch für Mineralogie, Geo-logie, und Paläontologie, Vol. 75A, pp. 145–158.

Caspi A. (1997) Modern diamond cutting and polishing. Gems & Gemology, Vol. 33, No. 2, pp. 102–121.

Connellan M., Pozzibon L. (1984) The Australian ideal design for round brilliants. Australian Gemmologist, Vol. 24, pp. 219–226, 243–246.

Crowningshield G.R., Moses T. (1997) Diamond: Damaged from wear. Gem Trade Lab Notes, Gems & Gemology, Vol. 33, No. 1, pp. 55–56.

Dodson J.S. (1979) The statistical brilliance, sparkliness and fire of the round brilliant-cut diamond. Diamond Research, pp. 13–17.

Elbe M.G. (1972) Erstaunliche Schmuckeffekte an Brillanten. Zeitschrift der Deutschen Gemmologischen Gesellschaft, Vol. 21, No. 4, pp. 189–212.

Eppler W.F. (1933) Der Diamant und seine Bearbeitung. Wilhelm Diebener GmbH, Leipzig, 68 pp.

Eppler W.F. (1938) Die Ideal-Schleifformen durchsichtiger Edelsteine. Zentralblatt für Mineralogie, Geologie, und Paläontologie, Abteilung A, pp. 1–5.

Eppler W.F. (1939) Die Brillanz durchsichtiger Edelsteine. Fortschritte der Mineralogie, Kristallographie, und Petrographie, Vol. 23, pp. 1–40.

Eppler W.F. (1940) Beitrag zum Brillanzproblem II. Zentralblatt für Mineralogie, Geologie, und Paläontologie, Abteilung A, No. 4, pp. 93–96.

Eppler W.F. (1973) Praktische Gemmologie. Rühle-Diebener Verlag KG, Stuttgart.

Eppler W.F., Klüppelberg E. (1940) Die praktische Brillantschliff des Diamanten. Neues Jahrbuch für Mineralogie, Geologie, und Paläontologie, Vol. 75A, pp. 135–144.

Eulitz W.R. (1972) Die rechnerische Ermittlung der optimalen Brillanz der Brillanten. Zeitschrift der Deutschen Gemmologischen Gesellschaft, Vol. 21, No. 1, pp. 13–43.

Federman D. (1997) Make believe. Modern Jeweler, Vol. 96, No. 9, pp. 23–38, 62–63.

Foley J.D., Ed. (1996) Computer Graphics: Principles and Practice, 2nd ed. in C, Addison-Wesley Publishing Co., Reading, MA.

GIA Diamond Dictionary, 3rd ed. (1993) Gemological Institute of America, Santa Monica, CA, 275 pp.

GIA Jeweler's Manual (1989) Gemological Institute of America, Santa Monica, CA, 327 pp.

Gilbertson A. (1998) Letting Light Speak for Itself. Diamond Profile Inc., Portland, Oregon, 14 pp. plus appendices.

Gilbertson A., Walters C. (1997) The measure of beauty. Rapaport Diamond Report, Vol. 20, No. 6, pp. 43, 45–46.

Johnsen A. (1926) Form und Brillanz der Brillanten. Sitzungsberichte der Preussischen Akademie der Wissenschaften, Physikalische-Mathematische Klasse, Vol. 23, pp. 322–330.

Lawrence J. (1998) Just how much sparkle? Diamond International, No. 53, pp. 77–78.

Maier W. (1936) Brillanz geschliffener Edelsteine. Neues Jahrbuch für Mineralogie, Geologie, und Paläontologie, Vol. 71A, pp. 458–491.

Maier W. (1938) Vollreflexbrillanten. Zentralblatt für Mineralogie, Geologie, und Paläontologie, Abteilung A, pp. 230–239.

Nassau K. (1983) The Physics and Chemistry of Color—The Fifteen Causes of Color. Wiley Interscience, New York, 454 pp.

Nestlebaum K. (1996) New AGS lab stakes its claim on cut grade. Rapaport Diamond Report, Vol. 19, No. 17, pp. 15–17.

Nestlebaum K. (1997) Ideals: Worth the trouble to those who cut them. Rapaport Diamond Report, Vol. 20, No. 10, pp. 18–19.

Papadopoulos A.D, Anastassakis E. (1991) Optical properties of diamond. Physical Review B, Vol. 43, No. 6, pp. 5090–5097.

Rösch S. (1926) Die Brillanzwirkung des geschliffenen Diamanten. Deutsche Goldschmiede Zeitung, No. 5, pp. 45–48; No. 7, pp. 65–67; No. 9, pp. 88–90.

Rösch S. (1927) Beitrag zum Brillanzproblem IV. Zeitschrift für Kristallographie, Vol. 65, pp. 46–68.

Scandinavian Diamond Nomenclature Committee (1979) The Scandinavian Diamond Nomenclature and Grading Standards: Official Version. Trade Associations of Jewellers in Denmark, Finland, Norway and Sweden, 50 pp.

Schlossmacher K. (1969) Edelsteine und Perlen, 5 Auflage. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart.

Shor R. (1993) Cutting grades—new complications. Jewelers' Circular-Keystone, Vol. 164, No. 4, pp. 52–55.

Shor R. (1997) Consumers who care about cut: A small, but growing group. Jewelers' Circular-Keystone, Vol. 168, No. 6, pp. 124–126.

Shor R. (1998) Computer engineers create proportion grade program. New York Diamonds, Vol. 44, pp. 26–28.

Stoephasius A. (1931) Lässt sich das Gewicht gefasster Brillanten sicher berechnen? Deutsche Goldschmiede Zeitung, No. 45, pp. 470–474.

Suzuki S. (1970) A new design for brilliance plus dispersion. Australian Gemmologist, Vol. 10, No. 10, pp. 13–24.

Tillander H. (1966) Six centuries of diamond design. Gems & Gemology, Vol. 12, No. 3, pp. 77–95.

Tillander H. (1995) Diamond Cuts in Historical Jewellery: 1381–1910. Art Books International, London.

Tognoni C. (1990) An automatic procedure for computing the optimum cut proportions of gems. La Gemmologia, Vol. 25, No. 3–4, pp. 23–32.

Tolkowsky G. (1996) Cutting the Edges. Diamond Insight, Vol. 9, No. 2, pp. 9–10.

Tolkowsky M. (1919) Diamond Design: A Study of the Reflection and Refraction of Light in a Diamond. E. & F.N. Spon, London.

Wade F.B. (1916) Diamonds: A Study of the Factors that Govern Their Value. G.P. Putnam's Sons, New York.

Ware, J.W. (1936) New diamond cuts break more easily. Gems & Gemology, Vol. 2, No. 4, p. 68.

Watermeyer B. (1991) Diamond Cutting, 4th ed. Preskor Doornfontein, Johannesburg, 406 pp.

Wright, W.D. (1969) The Measurement of Colour, 4th ed., Van Nostrand, New York.

Box A:

Detailed Description of One Diamond Model Embodiment

In one embodiment, the diamond model describes a faceted diamond as a convex polyhedron, a three-dimensional object with a surface that is bounded by flat planes and straight edges, with no indentations or clefts. The model requires that all surfaces be faceted, including the girdle, and currently excludes consideration of indented naturals or cavities. To date, we have focused our calculations on the round brilliant cut because of its dominant position in the market, but this model can be used for nearly any fully faceted shape. Our modeled round brilliant has mathematically perfect symmetry; all facets are perfectly shaped, pointed, and aligned. Also, all facet junctions are modeled with the same sharpness and depth.

Because our modeled round brilliant has perfect eight-fold symmetry, only eight numbers (proportion parameters) are required to specify the convex polyhedron that describes its shape (figure A-1). (Modeling other shapes or including asymmetries requires additional parameters). We defined these eight parameters as:

Crown angle	Angle (in degrees) between the bezel facets and the girdle plane
Pavilion angle	Angle (in degrees) between the pavilion mains and the girdle plane
Table size	Table width (as percent of girdle diameter)
Culet size	Culet width (as percent of girdle diameter)
Star facet length	The ratio of the length of the star facets to the distance between the table edge and girdle edge, as projected into the table plane
Lower-girdle length	The ratio of the length of the lower-girdle facets to the distance between the center of the culet and girdle edge, as projected into the table plane
Girdle thickness	Measured between bezel and pavilion main facets (the thick part of the girdle) and expressed as a percentage of girdle diameter. This differs from the typical use of the term girdle thickness (see, e.g., GIA Diamond Dictionary, 1993)
Girdle facets	Total number of girdle facets

Other proportions, such as the crown height, pavilion depth, and total depth (expressed as percentages of the girdle diameter) can be directly calculated from these eight parameters, using these formulas:

Crown height = 1 2(100 - table size) x tan(crown angle)
Pavilion depth = 1 2(100 - culet size) x tan(pavilion angle)
Total depth = (Crown height + pavilion depth + girdle thickness)

For the results in this application, the diamond simulated in our calculations (called a "virtual" diamond) has no inclusions, is perfectly polished, and is completely colorless. It has a polished girdle, not a bruted one, so that the girdle facets refract light rays in the same way that other facets do. The virtual diamond is non-dimensionalized, i.e. it has relative proportions but no absolute size—that is, no specific carat weight. The principles governing the way light moves through a colorless diamond do not vary with size, but some aspects of viewing a diamond do depend on its absolute size. A specific diameter can be applied to the virtual diamond for such purposes, or for others such as the application of a color or fluorescence spectrum.

We then chose modelled light sources to illuminate our virtual diamond. Results for brilliance (Hemphill et al., 1998) used a diffuse hemisphere of even, white light (D65 daylight illumination) shining on the crown. That illumination condition averages over the many different ambient light conditions in which diamonds are seen and worn, from the basic trading view of a diamond face-up in a tray next to large north-facing windows, to the common consumer experience of seeing a diamond worn outdoors or in a well-lit room. Such diffuse illumination emphasizes the return of white light, but it is a poor lighting condition for examining other fire and scintillation. These aspects are maximized by directed light, such as direct sunlight or the small halogen track lights common in many jewelry stores. Directed light is readily modeled as one or more point light sources at infinity or as a collimated finite-size spot at some other distance. For calculation of DCLR we used a D65 point light source at infinite distance, centered over the table. This illumination condition samples the maximum extent to which the round brilliant can disperse light. This same modelled lighting can be used to examine some

aspects of scintillation, although other aspects, particularly dynamic ones, will require more than one lighting position.

Next we examined mathematically how millions of rays of light from the source interact with the transparent, three-dimensional, colorless, fully faceted round brilliant specified by our choice of proportion parameters. Diamond is a dispersive material; the refractive index is different for different wavelengths of light. Since the angle of refraction depends on the refractive index, white light entering the virtual diamond is spread (dispersed) into rays of different colors, and each of these variously colored rays takes a slightly different path through the stone. We used Sellmeier's formula (see Nassau, 1983 [p. 211]; or, for a more thorough explanation, see Papadopoulos and Anastassakis, 1991) to incorporate this dispersion into the model. With this formula, we obtained the correct refractive index for each of the different colored rays (taken at 1 nm intervals from 360 to 830 nm), so that each ray could be traced (followed) along its correct path as it moved through the stone. Very few rays follow simple paths with only a few internal reflections; most follow complex three-dimensional paths (figure A-2).

Each time a ray strikes a facet, some combination of reflection and refraction takes place, depending on the angle between the ray and the facet, the refractive index at the wavelength of the ray, and the polarization state of the ray. Although the rays from our point light source are initially unpolarized, a light ray becomes partly polarized each time it bounces off a facet. The degree and direction of polarization affect how much of the ray is internally reflected, rather than refracted out the next time it intersects a facet. (For example, about 18% of a light ray approaching a diamond facet from the inside at an angle of 5° from the perpendicular is reflected, regardless of the polarization. But at an incidence of 70°, rays with polarization parallel to the plane of incidence are completely lost from the stone, while 55% of a ray polarized perpendicular to the plane of incidence is reflected back into the stone). The model traces each ray until 99.95% of its incident energy has exited the diamond. The end result of this ray tracing can be

an image of the virtual diamond (seen from a short distance or from infinity) or the value of a metric for that stone.

Although modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonable and properly come within the scope of their contribution to the art.

Claims

1. A method for providing a cut grade for a gemstone comprising the steps of:

illuminating a gemstone model with a modeled light source from infinite distance;

evaluating the fire of the gemstone model using a metric.

2. The method of Claim 1 further comprising the steps of refracting light elements through the gemstone model.

3. The method of Claim 2, wherein the step of evaluating fire using a metric that considers the total number of light elements, the length distribution of light elements and the angular distribution of the light elements for the gemstone model.

4. The method of Claim 3 wherein the step of evaluating fire using said metric further comprises the step of setting a power density threshold for said light elements.

5. A method for providing a cut grade for a gemstone comprising the steps of:

illuminating a gemstone model with a point light source at infinite distance;

refracting light elements, originating from the point light source, through the gemstone model;

evaluating the fire of the gemstone model using a metric.

6. The method of claim 5, further comprising the step of evaluating the fire of the gemstone comprises the step of recording light elements that appear to refract out of the crown of the gemstone model from the perspective of a hemispherical observer.

7. The method of claim 6, wherein said hemispherical observer is at an infinite distance from the gemstone model.

8. The method of claim 5, wherein the step of evaluating fire includes a calculation of DCLR.

9. The method of claim 8 wherein DCLR is the sum (over wavelength of the light elements) of the sum (over the number of light elements) of the differential area of each light element that exceeds a power density threshold criterion, multiplied by an exit angle weighting factor.

10. The method of claim 9, wherein said exit angle weighting factor is the square of the cosine of the exit angle.

11. The method of claim 9, wherein the sum of the number of light elements only counts refracted light elements that exceed a power density threshold based on the color sensitivity of the human eye.

12. The method of claim 9 wherein the power density threshold cutoff for a refracted light element is approximately 1% of the power density of the brightest light element.

13. The method of claim 9 wherein the power density threshold cutoff for a refracted light element is approximately .1% of the power density of the brightest light element.

14. The method of claim 9 wherein the power density threshold cutoff for a refracted light element is approximately .01% of the power density of the brightest light element.

15. A method for providing a cut grade for a gemstone comprising the steps of:

analyzing cut proportions of a gemstone;

comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on a calculation of dispersed color light return;

providing a grade for the gemstone based on said list of proportion grades.

16. The method of claim 15, wherein the grade provided incorporates an evaluation of gemstone symmetry.

17. The method of claim 15, wherein the grade provided incorporates an evaluation of polish

18. The method of claim 15, wherein the grade provided incorporates an evaluation of gemstone color.

19. The method of claim 15, wherein the grade provided incorporates an evaluation of fluorescence.

20. The method of claim 15, wherein the grade provided incorporates an evaluation of gemstone inclusions.

21. The method of claim 15, wherein the grade provided incorporates an evaluation of gemstone strain.

22. The method of claim 15, wherein the grade provided incorporates an evaluation of gemstone girdle condition.

23. The method of claim 15, wherein the grade combines an evaluation of fire and scintillation.

24. The method of claim 15, wherein the grade combines an evaluation of fire, brilliance and scintillation.

25. The method of claim 15, wherein the grade is a fire grade.

26. A method of creating a diamond grading report comprising the steps of:

evaluating the cut proportion of a diamond;

listing the cut proportions of the diamond on a diamond grading report;

comparing said cut proportions to a list of proportion grades that depend, at least in part, on a calculation of dispersed color light return;

inserting a digital image of a virtual diamond into the report, wherein said image is based, at least in part, on said list of proportion grades.

27. A method of creating a diamond grading report comprising the steps of:

evaluating the cut proportion of a diamond;

listing the cut proportions of the diamond on a diamond grading report;

comparing said cut proportions to a list of proportion grades that depend, at least in part, on a calculation of dispersed color light return;

providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

28. A method of providing target proportions for cutting a diamond comprising the steps of:

determining the size of an uncut gemstone;

comparing a list of possible cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on a calculation of dispersed color light return;

providing a target proportion for the gemstone based on said list of proportion grades.

29. A method of cutting a diamond comprising the steps of:

determining the size of an uncut diamond;

determining a possible cut proportion for the diamond;

comparing said possible cut proportion with a list of proportion grades that depend, at least in part, on a calculation of dispersed color light return;

cutting the uncut diamond.

30. A method for providing a cut grade for a gemstone comprising the steps of:

analyzing cut proportions of a gemstone;

comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on culet size;

providing a grade for gemstone fire based on said list of proportion grades.

31. A method for providing a cut grade for a gemstone comprising the steps of:

analyzing cut proportions of a gemstone;

comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on table size;

providing a grade for gemstone fire based on said list of proportion grades.

32. A method for providing a cut grade for a gemstone comprising the steps of:

analyzing cut proportions of a gemstone;

comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on crown angle;

providing a grade for gemstone fire based on said list of proportion grades.

33. A method for providing a cut grade for a gemstone comprising the steps of:

analyzing cut proportions of a gemstone;

comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on pavilion angle;

providing a grade for gemstone fire based on said list of proportion grades.

34. A method for providing a cut grade for a gemstone comprising the steps of:

analyzing cut proportions of a gemstone;

comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on the number of girdle facets;

providing a grade for gemstone fire based on said list of proportion grades.

35. A method for providing a cut grade for a gemstone comprising the steps of:

analyzing cut proportions of a gemstone;

comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on girdle thickness;

providing a grade for gemstone fire based on said list of proportion grades.

36. A method for providing a cut grade for a gemstone comprising the steps of:

analyzing cut proportions of a gemstone;

comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on star facet length.

providing a grade for gemstone fire based on said list of proportion grades.

37. A method for providing a cut grade for a gemstone comprising the steps of:

analyzing cut proportions of a gemstone;

comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on lower girdle length;

providing a grade for gemstone fire based on said list of proportion grades.

38. A method of creating a diamond grading report comprising the steps of:

evaluating the cut proportion of a diamond;

listing the cut proportions of the diamond on a diamond grading report;

comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on table size;

providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

39. The method of claim 38, wherein said numerical grade is a fire grade.

40. A method of creating a diamond grading report comprising the steps of:

evaluating the cut proportion of a diamond;

listing the cut proportions of the diamond on a diamond grading report;

comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on crown angle;

providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

41. The method of claim 40, wherein said numerical grade is a fire grade.

42. A method of creating a diamond grading report comprising the steps of:

evaluating the cut proportion of a diamond;

listing the cut proportions of the diamond on a diamond grading report;

comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on pavilion angle;

providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

43. The method of claim 42, wherein said numerical grade is a fire grade.

44. A method of creating a diamond grading report comprising the steps of:

evaluating the cut proportion of a diamond;

listing the cut proportions of the diamond on a diamond grading report;

comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on the number of girdle facets;

providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

45. The method of claim 44, wherein said numerical grade is a fire grade.

46. A method of creating a diamond grading report comprising the steps of:

evaluating the cut proportion of a diamond;

listing the cut proportions of the diamond on a diamond grading report;

comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on girdle thickness;

providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

47. The method of claim 46, wherein said numerical grade is a fire grade.

48. A method of creating a diamond grading report comprising the steps of:

evaluating the cut proportion of a diamond;

listing the cut proportions of the diamond on a diamond grading report;

comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on star facet length;

providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

49. The method of claim 48, wherein said numerical grade is a fire grade.

50. A method of creating a diamond grading report comprising the steps of:

evaluating the cut proportion of a diamond;

listing the cut proportions of the diamond on a diamond grading report;

comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on lower girdle length;

providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

51. The method of claim 50, wherein said numerical grade is a fire grade.

52. A method of creating a diamond grading report comprising the steps of:

evaluating the cut proportion of a diamond;

listing the cut proportions of the diamond on a diamond grading report;

comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on culet size;

providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

53. The method of claim 52, wherein said numerical grade is a fire grade.

54. A system for providing a cut grade for a gemstone comprising:

means for illuminating a gemstone model with a modeled light source from infinite distance; and

means for evaluating the fire of the gemstone model using a metric.

55. The system of Claim 54 further comprising a means for refracting light elements through the gemstone model.

56. The system of Claim 55, wherein the means for evaluating fire uses a metric that considers the total number of light elements, the length distribution of light elements and the angular distribution of the light elements for the gemstone model.

57. The system of Claim 56 wherein the means for evaluating fire using said metric further comprises the step of setting a power density threshold for said light elements.

58. A system for providing a cut grade for a gemstone comprising:

a means for illuminating a gemstone model with a point light source at infinite distance;

a means for refracting light elements, originating from the point light source, through the gemstone model; and

a means for evaluating the fire of the gemstone model using a metric.

59. The system of claim 56, wherein the means for evaluating the fire of a gemstone comprises a means for recording light elements that appear to refract out of the crown of the gemstone model from the perspective of a hemispherical observer.

60. The system of claim 57, wherein said hemispherical observer is at an infinite distance from the gemstone model.

61. The system of claim 56, wherein the means for evaluating fire includes a means for calculation of DCLR.

62. The system of claim 59 wherein DCLR is the sum (over wavelength of the light elements) of the sum (over the number of light elements) of the differential area of each light element that exceeds a power density threshold criterion, multiplied by an exit angle weighting factor.

63. The system of claim 60, wherein said exit angle weighting factor is the square of the cosine of the exit angle.

64. The system of claim 60, wherein the sum of the number of light element traces only counts light elements that exceed a power density threshold based on the color sensitivity of the human eye.

65. The system of claim 60 wherein the power density threshold cutoff for a refracted light element is approximately 1% of the power density of the brightest light element.

66. The system of claim 60 wherein the power density threshold cutoff for a refracted light element is approximately .1% of the power density of the brightest light element.

67. The system of claim 66 wherein the power density threshold cutoff for a refracted light element is approximately .01% of the power density of the brightest light element.

68. A system for providing a cut grade for a gemstone comprising the steps of:

a means for analyzing cut proportions of a gemstone;

a means for comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on a calculation of dispersed color light return;

a means for providing a grade for the gemstone based on said list of proportion grades.

69. The system of claim 66, wherein the means for providing a grade comprises a means for evaluating gemstone symmetry.

70. The system of claim 66, wherein the means for providing a grade comprises a means for evaluating polish

71. The system of claim 66, wherein the means for providing a grade comprises a means for evaluating gemstone color.

72. The system of claim 66, wherein the means for providing a grade comprises a means for evaluating fluorescence.

73. The system of claim 66, wherein the means for providing a grade comprises a means for evaluating gemstone inclusions.

74. The system of claim 66, wherein the means for providing a grade comprises a means for evaluating gemstone strain.

75. The system of claim 66, wherein the means for providing a grade comprises a means for evaluating girdle condition.

76. The system of claim 66, wherein the means for providing a grade comprises a means for evaluating fire and scintillation.

77. The system of claim 66, wherein the means for providing a grade comprises a means for evaluating fire, brilliance and scintillation.

78. The system of claim 66, wherein the means for providing a grade comprises a means for providing a fire grade.

79. A system of creating a diamond grading report comprising:

a means for evaluating the cut proportion of a diamond;

a means for listing of cut proportions of the diamond on a diamond grading report;

a means for comparing said cut proportions to a list of proportion grades that depend, at least in part, on a calculation of dispersed color light return;

a means for inserting a digital image of a virtual diamond into the report, wherein said image is based, at least in part, on said list of proportion grades.

80. A system for creating a diamond grading report comprising:

a means for evaluating the cut proportion of a diamond;

a means for listing the cut proportions of the diamond on a diamond grading report;

a means for comparing said cut proportions to a list of proportion grades that depend, at least in part, on a calculation of dispersed color light return;

a means for providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

81. A system for providing target proportions for cutting a diamond comprising:

a means for comparing a list of possible cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on a calculation of dispersed color light return;

a means, incorporating a processor, for providing a target proportion for the gemstone based on said list of proportion grades.

82. A system for cutting a diamond comprising:

a means for determining a possible cut proportion for the diamond;

a means for comparing said possible cut proportion with a list of proportion grades that depend, at least in part, on a calculation of dispersed color light return.

83. A system for providing a cut grade for a gemstone comprising:

a means for analyzing cut proportions of a gemstone;

a means for comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on culet size;

a means for providing a grade for gemstone fire based on said list of proportion grades.

84. A system for providing a cut grade for a gemstone comprising the steps of:

a means for analyzing cut proportions of a gemstone;

a means for comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on table size;

a means for providing a grade for gemstone fire based on said list of proportion grades.

85. A system for providing a cut grade for a gemstone comprising:

means for analyzing cut proportions of a gemstone;

means for comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on crown angle;

means for providing a grade for gemstone fire based on said list of proportion grades.

86. A system for providing a cut grade for a gemstone comprising:

means for analyzing cut proportions of a gemstone;

means for comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on pavilion angle;

means for providing a grade for gemstone fire based on said list of proportion grades.

87. A system for providing a cut grade for a gemstone comprising:

means for analyzing cut proportions of a gemstone;

means for comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on the number of girdle facets;

means for providing a grade for gemstone fire based on said list of proportion grades.

88. A system for providing a cut grade for a gemstone comprising:

means for analyzing cut proportions of a gemstone;

means for comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on girdle thickness;

means for providing a grade for gemstone fire based on said list of proportion grades.

89. A system for providing a cut grade for a gemstone comprising:

means for analyzing cut proportions of a gemstone;

means for comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on star facet length.

means for providing a grade for gemstone fire based on said list of proportion grades.

90. A system for providing a cut grade for a gemstone comprising:

means for analyzing cut proportions of a gemstone;

means for comparing the cut proportions of the gemstone with a list of proportion grades that depend, at least in part, on lower girdle length;

means for providing a grade for gemstone fire based on said list of proportion grades.

91. A system for creating a diamond grading report comprising:

a means for listing cut proportions of the diamond on a diamond grading report;

a means for comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on table size;

a means for providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

92. The system of claim 63, wherein said numerical grade is a fire grade.

93. A system for creating a diamond grading report comprising:

means for evaluating the cut proportion of a diamond;

means for listing the cut proportions of the diamond on a diamond grading report;

means for comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on crown angle;

means for providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

94. The system of claim 93, wherein said numerical grade is a fire grade.

95. A system for creating a diamond grading report comprising:

means for evaluating the cut proportion of a diamond;

means for listing the cut proportions of the diamond on a diamond grading report;

means for comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on pavilion angle;

means for providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

96. The system of claim 95, wherein said numerical grade is a fire grade.

97. A system for creating a diamond grading report comprising:

means for evaluating the cut proportion of a diamond;

means for listing the cut proportions of the diamond on a diamond grading report;

means for comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on the number of girdle facets;

means for providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

98. The system of claim 97, wherein said numerical grade is a fire grade.

99. A system for creating a diamond grading report comprising:

means for evaluating the cut proportion of a diamond;

means for listing the cut proportions of the diamond on a diamond grading report;

means for comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on girdle thickness;

means for providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

100. The system of claim 99, wherein said numerical grade is a fire grade.

101. A system for creating a diamond grading report comprising:

means for evaluating the cut proportion of a diamond;

means for listing the cut proportions of the diamond on a diamond grading report;

means for comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on star facet length;

means for providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

102. The system of claim 101, wherein said numerical grade is a fire grade.

103. A system for creating a diamond grading report comprising:

means for evaluating the cut proportion of a diamond;

means for listing the cut proportions of the diamond on a diamond grading report;

means for comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on lower girdle length;

means for providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

104. The system of claim 103, wherein said numerical grade is a fire grade.

105. A system for creating a diamond grading report comprising:

means for evaluating the cut proportion of a diamond;

means for listing the cut proportions of the diamond on a diamond grading report;

means for comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on culet size;

means for providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

106. The system of claim 105, wherein said numerical grade is a fire grade.

107. A system for creating a diamond grading report comprising:

means for evaluating the cut proportion of a diamond;

means for listing the cut proportions of the diamond on a diamond grading report;

means for comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on crown height;

means for providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

108. The system of claim 107, wherein said numerical grade is a fire grade.

109. A system for creating a diamond grading report comprising:

means for evaluating the cut proportion of a diamond;

means for listing the cut proportions of the diamond on a diamond grading report;

means for comparing said cut proportions to a list of proportion grades that comprise an evaluation of diamond fire and depend, at least in part, on pavilion depth;

means for providing a numerical grade of said diamond in the report, wherein said numerical grade is based, at least in part, on said list of proportion grades.

110. The system of claim 109, wherein said numerical grade is a fire grade.

ABSTRACT

Of the "four C's," cut has historically been the most complex to understand and assess. This application presents a three-dimensional mathematical model to study the interaction of light with a fully faceted, colorless, symmetrical round-brilliant-cut diamond. With this model, one can analyze how various appearance factors (brilliance, fire, and scintillation) depend on proportions. The model generates images and a numerical measurement of the optical efficiency of the round brilliant—called DCLR — which approximates overall fire. DCLR values change with variations in cut proportions, in particular crown angle, pavilion angle, table size, star facet length, culet size, and lower girdle facet length. The invention describes many combinations of proportions with equal or higher DCLR than "Ideal" cuts, and these DCLR ratings may be balanced with other factors such as brilliance and scintillation to provide a cut grade for an existing diamond or a cut analysis for prospective cut of diamond rough.

List Reference

Fig. 1

BOX A:
BASIC DESCRIPTION OF OUR MODEL

We describe a faceted diamond as a convex polyhedron, a three-dimensional object with a surface that is bounded by flat planes and straight edges, with no indentations or clefts. The model requires that all surfaces be faceted, including the girdle, and currently excludes consideration of indented naturals or cavities. To date, we have focused our calculations on the round brilliant cut because of its dominant position in the market, but this model can be used for nearly any fully faceted shape. Our modeled round brilliant has mathematically perfect symmetry; that is, all facets are perfectly shaped, pointed, and aligned. Also, all facet junctions are modeled with the same sharpness and depth.

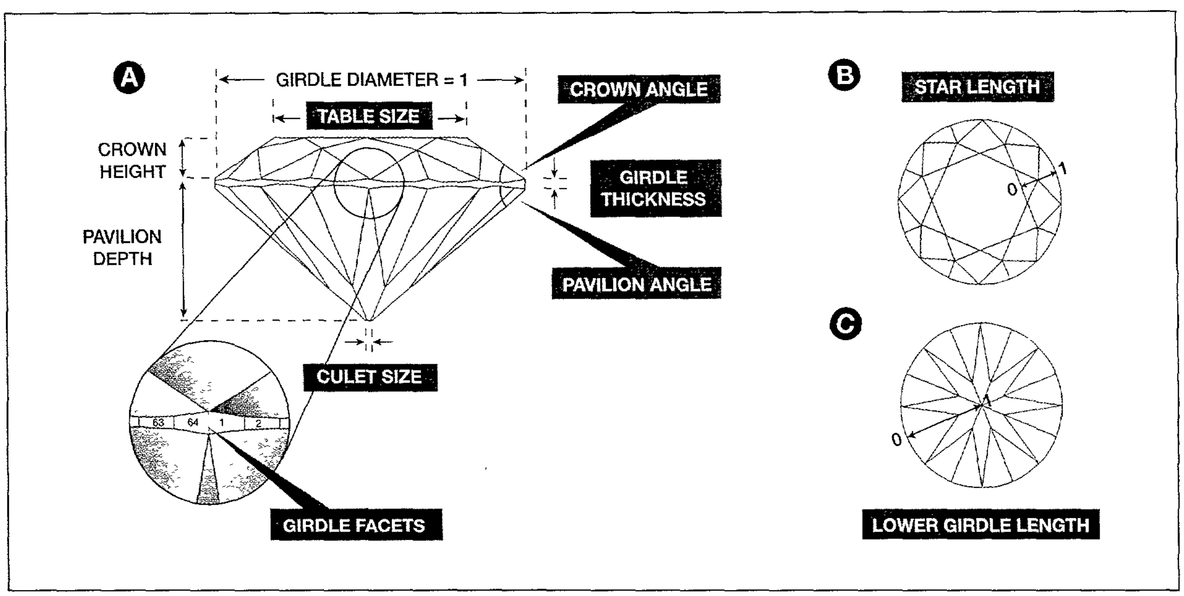
Because our modeled round brilliant has perfect eight-fold symmetry, only eight numbers (parameters) are required to specify the convex polyhedron that describes its shape (figure A-1). (Modeling other shapes or including asymmetries requires additional parameters.) We defined these eight parameters as:

Crown angle	Angle (in degrees) between the bezel facets and the girdle plane
Pavilion angle	Angle (in degrees) between the pavilion mains and the girdle plane
Table size	Table width (as percent of girdle diameter)
Culet size	Culet width (as percent of girdle diameter)
Star length	The ratio of the length of the star facets to the distance between the table edge and girdle edge
Lower-girdle length	The ratio of the length of the lower-girdle facets to the distance between the center of the culet and girdle edge
Girdle thickness	Measured between bezel and pavilion main facets (the thick part of the girdle) and expressed as a percentage of girdle diameter. This differs from the typical use of the term *girdle thickness* (see, e.g., *GIA Diamond Dictionary*, 1993)
Girdle facets	Total number of girdle facets

Other proportions, such as the crown height, pavilion depth, and total depth (expressed as percentages of

Figure A-1. We used eight parameters—varied across the range given in table 4—to define our geometric model of the round brilliant shape. (A) All linear distances in this profile view can be described as a percentage of the girdle diameter. The enlarged view of the girdle is centered on the position where we measured the girdle thickness. (B) In this view of the table, the star length *is shown at 50%, so that the star facets extend halfway from the table to the girdle (when viewed from straight above). (C) In this view of the pavilion, the* lower-girdle length *is shown at 75%, so that the lower girdle facets extend three-fourths of the distance from the girdle to the culet (when viewed from straight below).*

FIG. 1



DCLR VARIES WITH CROWN ANGLE

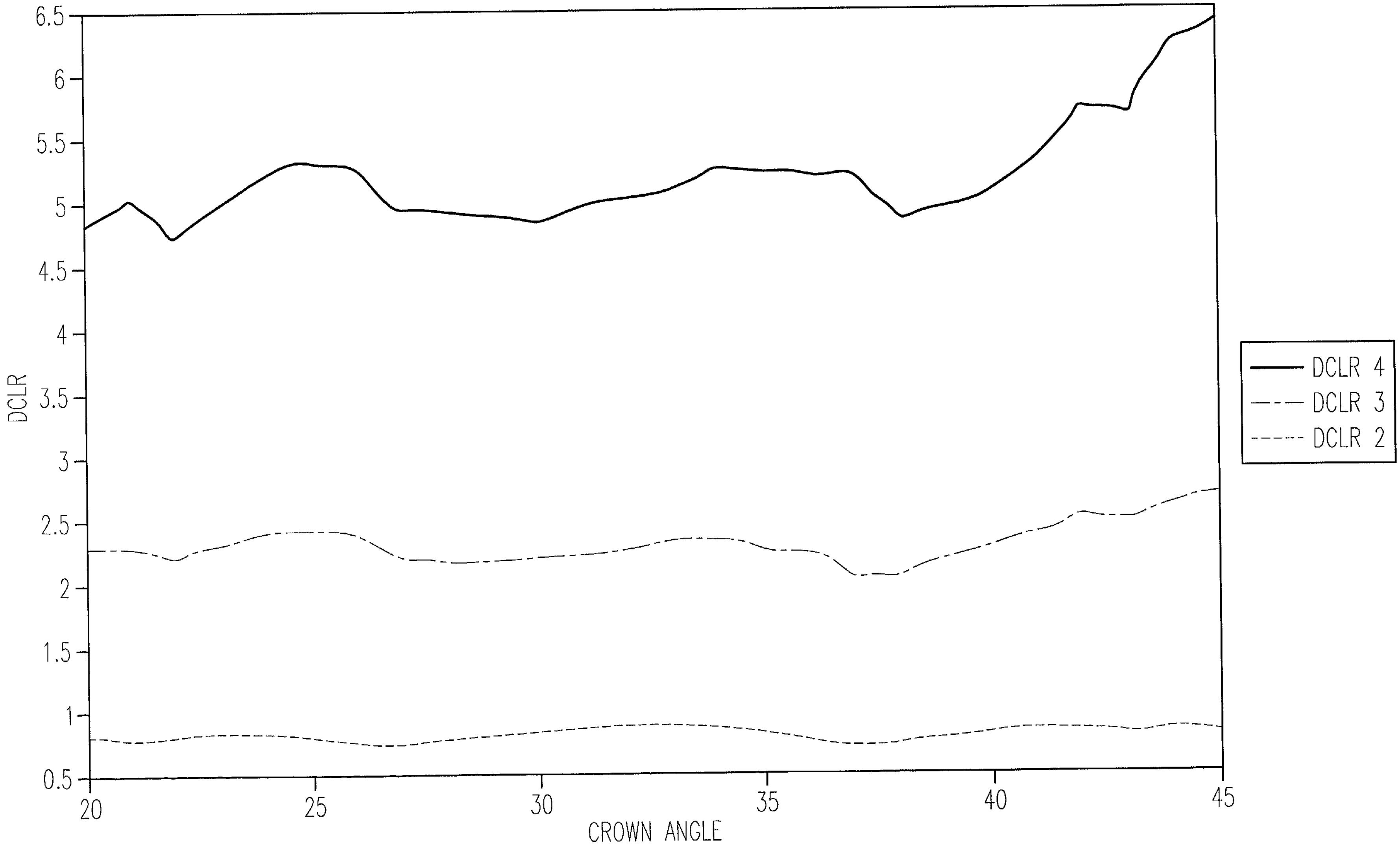


FIG. 2

Fig. 2

Fire Varies with Crown Angle

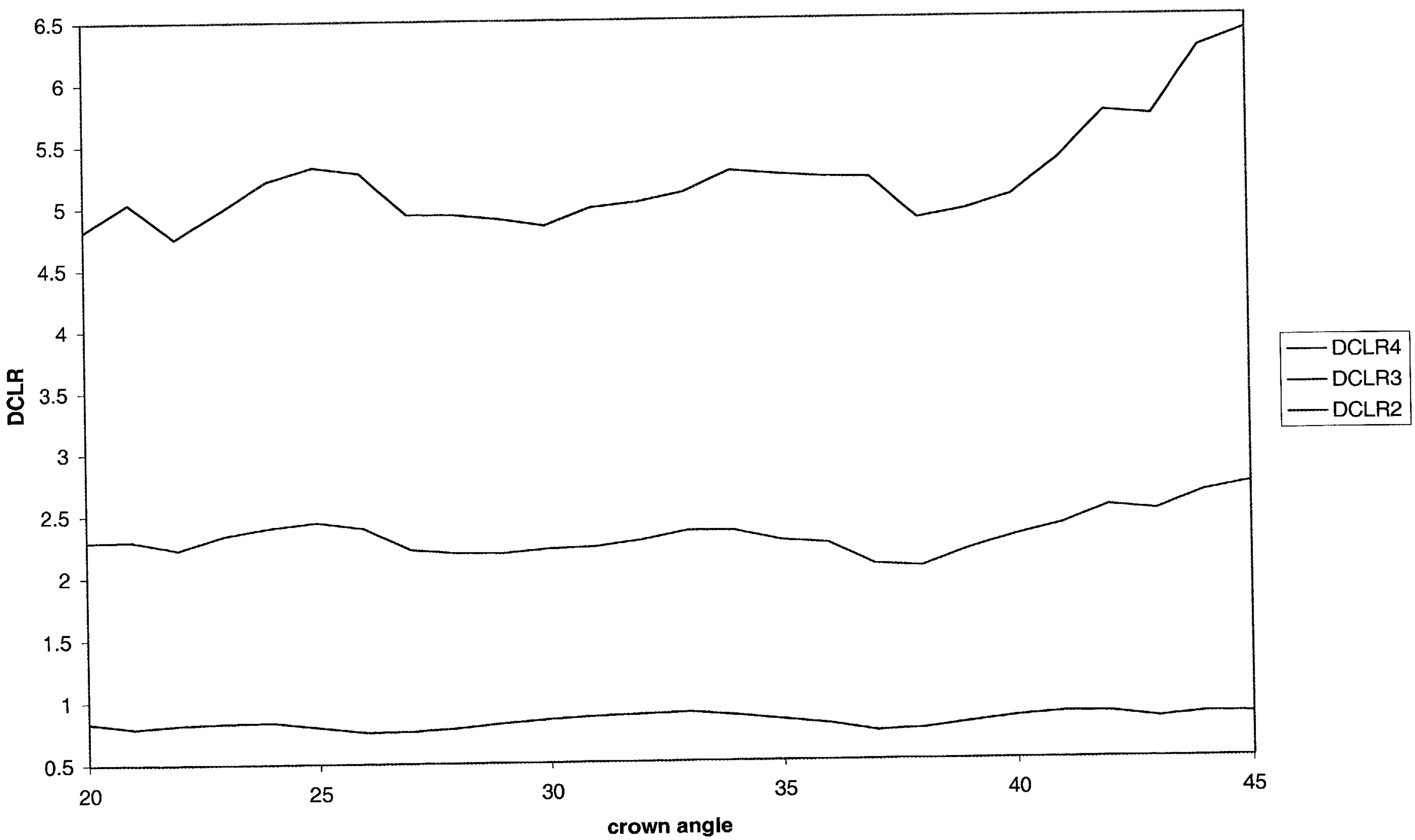


Fig. 2

Crown Angle	Pavilion Angle	Table Size	Girdle	Star Length	Lower Girdle Length	Culet Size	# of Girdle Facets	Crown Angle	DCLR4	DCLR3	DCLR2
20	40.5	0.56	0.005	0.5	0.75	0.03	64	20	4.808136	2.290357	0.832502
21	40.5	0.56	0.005	0.5	0.75	0.03	64	21	5.030344	2.294424	0.787851
22	40.5	0.56	0.005	0.5	0.75	0.03	64	22	4.746925	2.224495	0.816247
23	40.5	0.56	0.005	0.5	0.75	0.03	64	23	4.976609	2.33858	0.829484
24	40.5	0.56	0.005	0.5	0.75	0.03	64	24	5.208604	2.399793	0.833867
25	40.5	0.56	0.005	0.5	0.75	0.03	64	25	5.320519	2.441463	0.793886
26	40.5	0.56	0.005	0.5	0.75	0.03	64	26	5.270065	2.391322	0.753839
27	40.5	0.56	0.005	0.5	0.75	0.03	64	27	4.935745	2.216659	0.755395
28	40.5	0.56	0.005	0.5	0.75	0.03	64	28	4.930896	2.188527	0.77895
29	40.5	0.56	0.005	0.5	0.75	0.03	64	29	4.892483	2.183266	0.818271
30	40.5	0.56	0.005	0.5	0.75	0.03	64	30	4.837468	2.215199	0.847369
31	40.5	0.56	0.005	0.5	0.75	0.03	64	31	4.976839	2.227878	0.866889
32	40.5	0.56	0.005	0.5	0.75	0.03	64	32	5.019174	2.277004	0.87894
33	40.5	0.56	0.005	0.5	0.75	0.03	64	33	5.095637	2.352677	0.892496
34	40.5	0.56	0.005	0.5	0.75	0.03	64	34	5.266954	2.345421	0.863241
35	40.5	0.56	0.005	0.5	0.75	0.03	64	35	5.234717	2.266483	0.82614
36	40.5	0.56	0.005	0.5	0.75	0.03	64	36	5.211515	2.242278	0.788502
37	40.5	0.56	0.005	0.5	0.75	0.03	64	37	5.202454	2.064508	0.726241
38	40.5	0.56	0.005	0.5	0.75	0.03	64	38	4.8685	2.044293	0.742737
39	40.5	0.56	0.005	0.5	0.75	0.03	64	39	4.937516	2.184872	0.794879
40	40.5	0.56	0.005	0.5	0.75	0.03	64	40	5.051162	2.290029	0.838353
41	40.5	0.56	0.005	0.5	0.75	0.03	64	41	5.341886	2.37774	0.866865
42	40.5	0.56	0.005	0.5	0.75	0.03	64	42	5.722286	2.521091	0.862799
43	40.5	0.56	0.005	0.5	0.75	0.03	64	43	5.690082	2.486346	0.818338
44	40.5	0.56	0.005	0.5	0.75	0.03	64	44	6.240864	2.632991	0.855382
45	40.5	0.56	0.005	0.5	0.75	0.03	64	45	6.378598	2.700116	0.851092

DCLR VARIES WITH PAVILION ANGLE

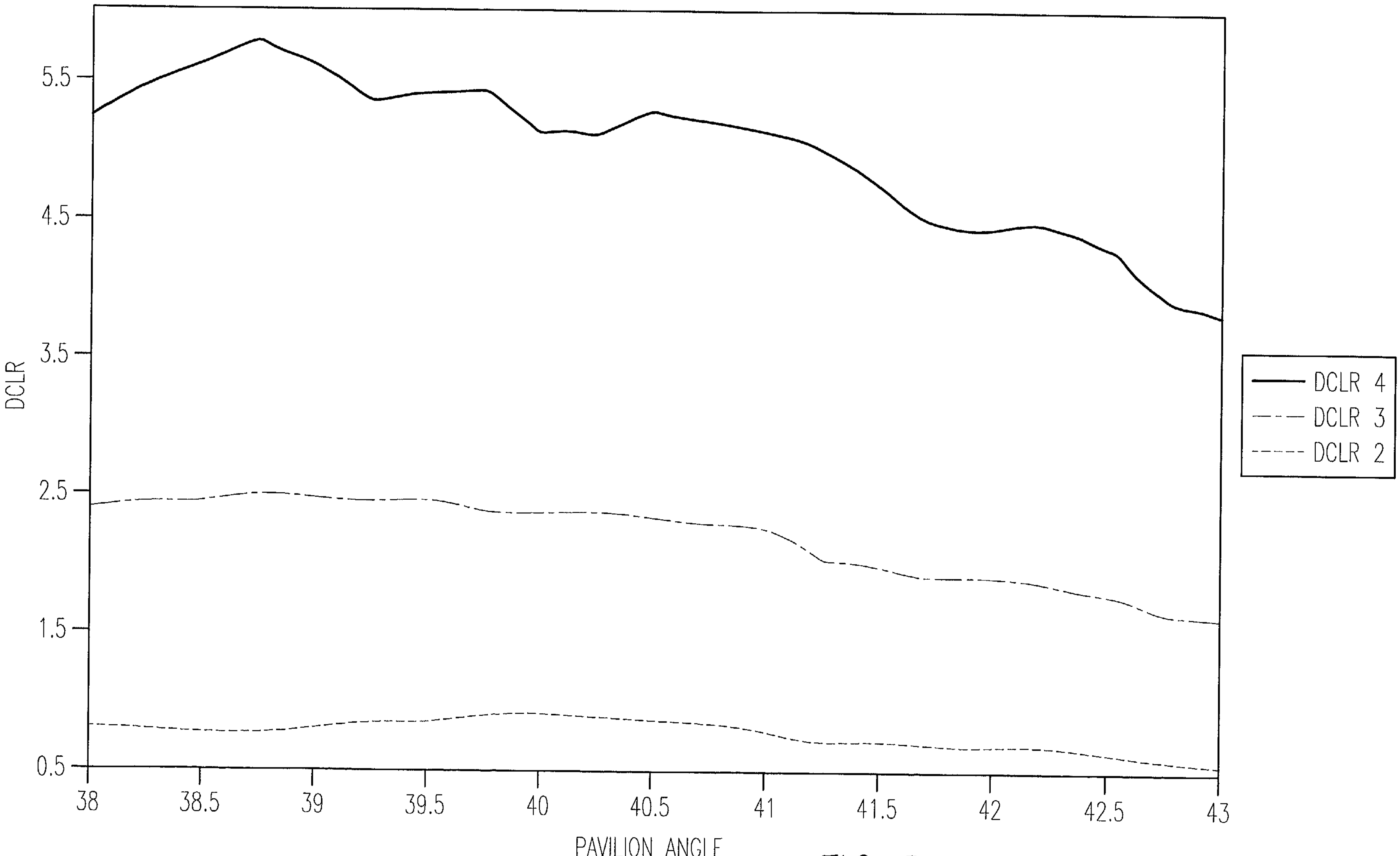


FIG. 3

Fig. 3

Fire Varies with Pavilion Angle

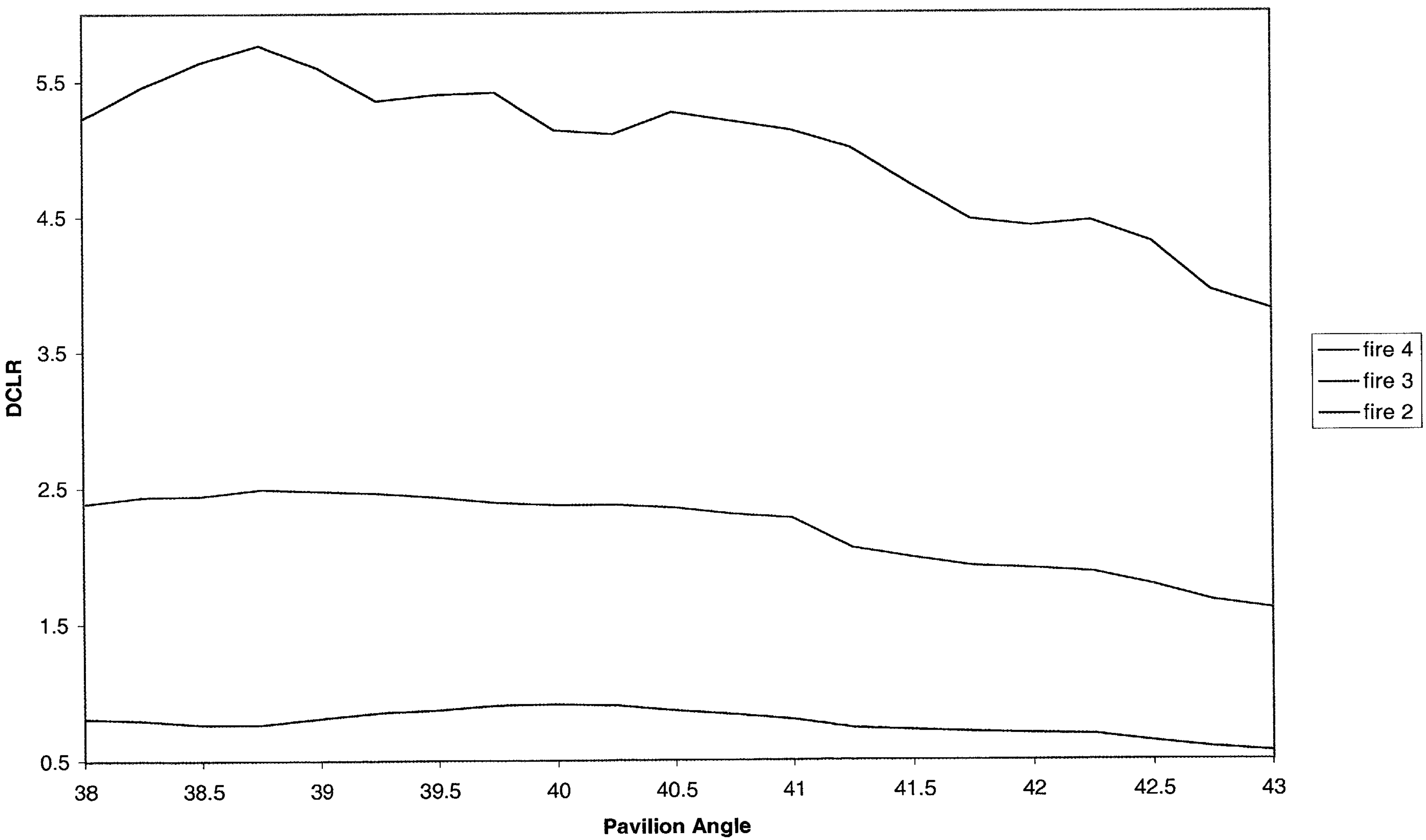


Fig. 3

Crown Angle	Pavilion	Table Size	Girdle	Star Length	Lower Girdle Length	Culet Size	# of Girdle Facets	Pavilion	DCLR4	DCLR3	DCLR2
34	38	0.56	0.005	0.5	0.75	0.03	64	38	5.229829	2.384859	0.810342
34	38.25	0.56	0.005	0.5	0.75	0.03	64	38.25	5.453779	2.430965	0.79447
34	38.5	0.56	0.005	0.5	0.75	0.03	64	38.5	5.638591	2.438316	0.76528
34	38.75	0.56	0.005	0.5	0.75	0.03	64	38.75	5.765021	2.485844	0.765746
34	39	0.56	0.005	0.5	0.75	0.03	64	39	5.596684	2.472669	0.810468
34	39.25	0.56	0.005	0.5	0.75	0.03	64	39.25	5.353917	2.458902	0.851028
34	39.5	0.56	0.005	0.5	0.75	0.03	64	39.5	5.401111	2.428729	0.868444
34	39.75	0.56	0.005	0.5	0.75	0.03	64	39.75	5.414612	2.386446	0.901324
34	40	0.56	0.005	0.5	0.75	0.03	64	40	5.133628	2.368464	0.908834
34	40.25	0.56	0.005	0.5	0.75	0.03	64	40.25	5.105611	2.367006	0.897934
34	40.5	0.56	0.005	0.5	0.75	0.03	64	40.5	5.266954	2.345421	0.863241
34	40.75	0.56	0.005	0.5	0.75	0.03	64	40.75	5.197605	2.297761	0 831788
34	41	0.56	0.005	0.5	0.75	0.03	64	41	5.132326	2.267499	0.794494
34	41.25	0.56	0.005	0.5	0.75	0.03	64	41.25	5.000269	2.048954	0.729545
34	41.5	0.56	0.005	0.5	0.75	0.03	64	41.5	4.728625	1.976045	0.714573
34	41.75	0.56	0.005	0.5	0.75	0.03	64	41.75	4.471355	1.912248	0.700948
34	42	0.56	0.005	0.5	0.75	0.03	64	42	4.42342	1.896277	0.688704
34	42.25	0.56	0.005	0.5	0.75	0.03	64	42.25	4.461586	1.866763	0.6823
34	42.5	0.56	0.005	0.5	0.75	0.03	64	42.5	4.302394	1.77687	0.630612
34	42.75	0.56	0 005	0.5	0.75	0.03	64	42.75	3.9399	1.660786	0.584443
34	43	0.56	0.005	0.5	0.75	0.03	64	43	3.803905	1.598593	0.554585

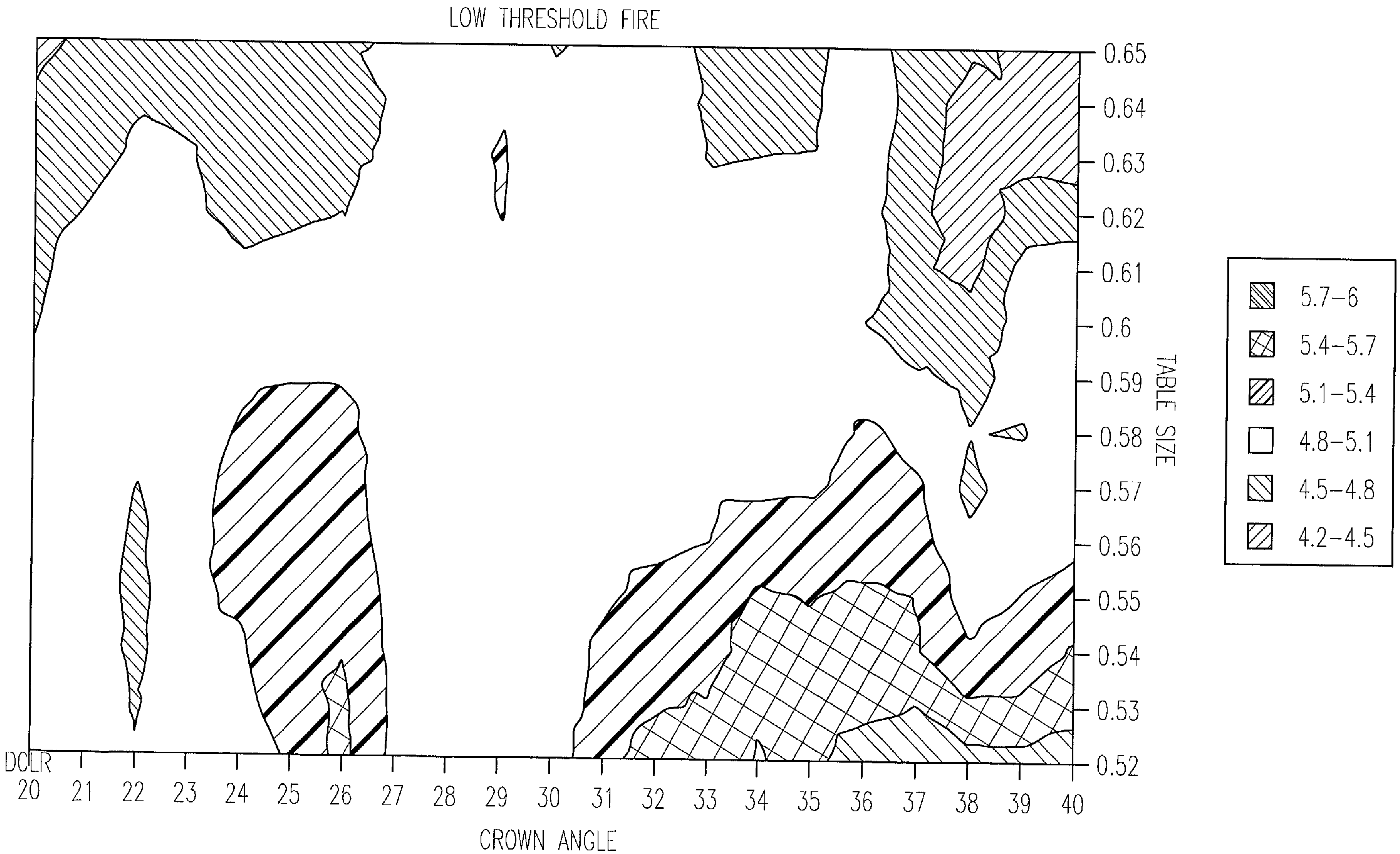
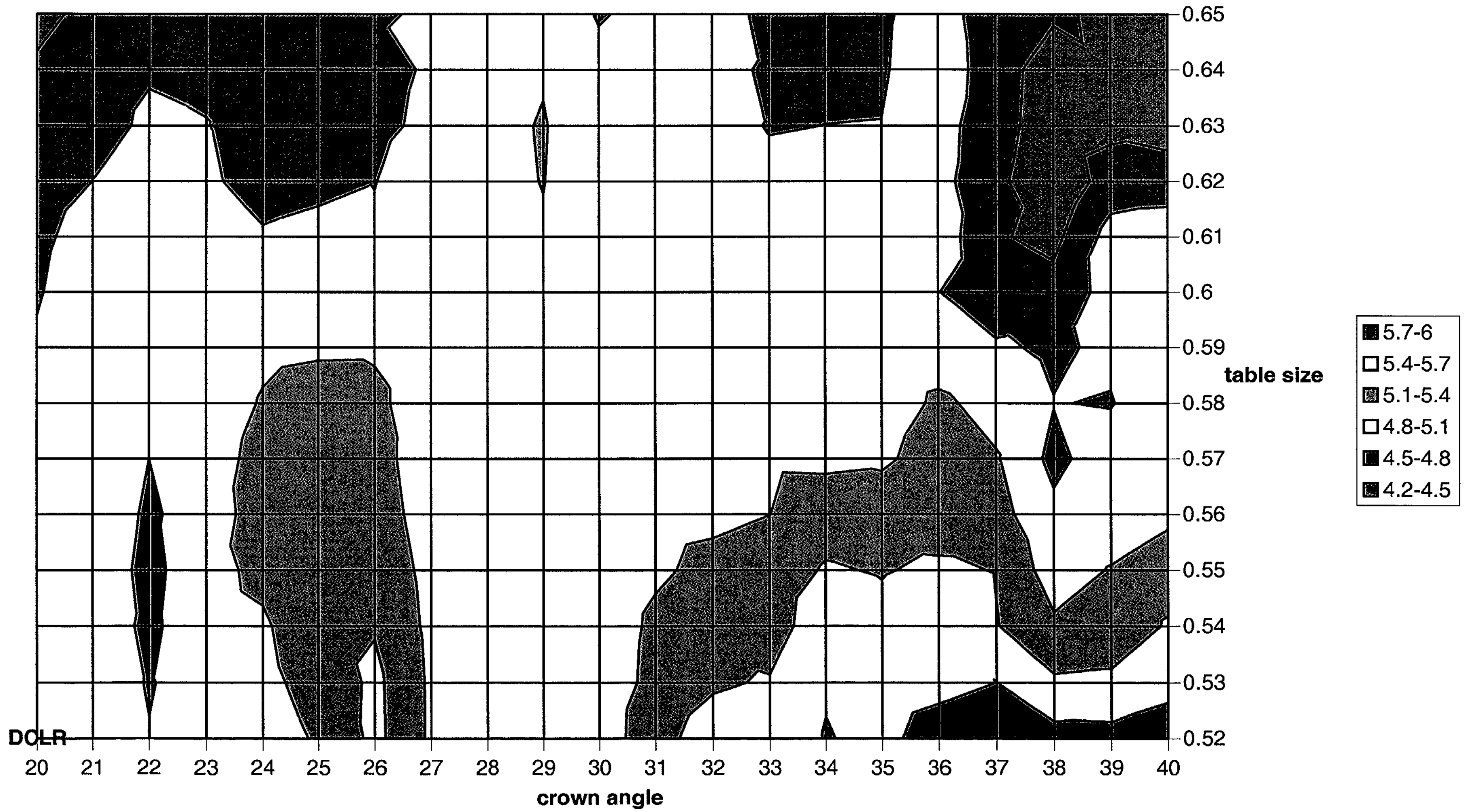

LOW THRESHOLD FIRE
0.65
0.64
0.63
0.62
0.61
0.6
0.59
0.58
0.57
0.56
0.55
0.54
0.53
0.52
TABLE SIZE
DCLR
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
CROWN ANGLE
5.7–6
5.4–5.7
5.1–5.4
4.8–5.1
4.5–4.8
4.2–4.5

FIG. 4

Fig. 4

Low Threshold Fire



DCLR (with reference to crown angle and table size) - Low Threshold

Table Size																					
	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
0.52	4.820357	4.939313	4.812195	4.879748	4.932132	5.136546	5.47201	5.046131	5.022919	4.900264	4.924492	5.300924	5.547221	5.409065	5.719851	5.597977	5.884889	5.917144	5.80973	5.789427	5.873313
0.53	4.831093	4.950311	4.782181	4.936139	5.029274	5.203716	5.462488	5.049688	4.971674	4.856816	4.907846	5.193917	5.361343	5.42549	5.667448	5.489215	5.587521	5.701767	5.446033	5.477491	5.601666
0.54	4.815453	4.973568	4.73973	4.99687	5.064955	5.275224	5.381007	5.025958	4.971243	4.864711	4.860688	5.180024	5.30072	5.246033	5.599147	5.50736	5.668524	5.41251	5.147505	5.164859	5.435375
0.55	4.81028	5.009988	4.709252	5.015546	5.160558	5.316428	5.324799	5.001634	4.987571	4.850012	4.831711	5.041646	5.205475	5.209404	5.428893	5.377802	5.465541	5.386262	4.957486	5.116674	5.231116
0.56	4.808136	5.030344	4.746925	4.976609	5.208604	5.320519	5.270065	4.935745	4.930896	4.892483	4.837468	4.976839	5.019174	5.095637	5.266954	5.234717	5.211515	5.202454	4.8685	4.937516	5.051162
0.57	4.830171	5.026022	4.799962	4.914508	5.230896	5.301702	5.229205	4.887668	4.885941	4.911941	4.829027	4.941537	4.869972	5.04464	5.037557	5.061297	5.20193	5.123727	4.72041	4.966408	4.988474
0.58	4.839072	5.026973	4.853691	4.866287	5.127808	5.232636	5.171616	4.898555	4.891339	4.914794	4.848868	4.867236	4.85868	4.910679	4.934068	4.926477	5.154472	4.994656	4.809853	4.780978	5.034633
0.59	4.832706	4.982412	4.913689	4.828904	5.028446	5.06001	5.063859	4.898404	4.923511	4.923349	4.835056	4.829714	4.884636	4.808952	4.934716	4.874027	4.939944	4.849796	4.74409	4.865011	5.021238
0.6	4.776394	4.960796	4.925031	4.837148	4.928928	4.972889	4.94316	4.856815	4.979128	5.001942	4.839071	4.871782	4.877656	4.829757	4.923382	4.867877	4.808313	4.560933	4.618767	4.896856	4.966398
0.61	4.744611	4.902197	4.945129	4.852798	4.834193	4.881712	4.829108	4.954681	5.025748	5.084723	4.90441	4.855851	4.821782	4.872046	4.922016	4.850042	4.95823	4.532966	4.411391	4.908094	4.921952
0.62	4.688475	4.801576	4.95931	4.852435	4.67493	4.733005	4.794239	4.9282	5.052294	5.104288	4.985726	4.928198	4.859495	4.846723	4.819245	4.816324	4.888901	4.577857	4.231437	4.647369	4.69605
0.63	4.648858	4.677046	4.855552	4.817368	4.600331	4.62899	4.751064	4.846364	5.05549	5.109083	5.003274	4.924906	4.88104	4.789814	4.80074	4.803556	4.898934	4.634762	4.320362	4.423799	4.344308
0.64	4.537254	4.648348	4.771252	4.697781	4.578892	4.596966	4.716511	4.830715	5.021953	5.088545	4.904007	4.980077	4.944995	4.74344	4.76932	4.77176	4.960207	4.654107	4.333075	4.459725	4.245546
0.65	4.424109	4.57592	4.60562	4.551181	4.548646	4.609783	4.790281	4.810596	4.966058	5.034687	4.773245	4.898147	5.056408	4.666156	4.686667	4.762845	4.919437	4.63904	4.543718	4.445769	4.209061
5.917144	4.839072	5.030344	4.95931	5.015546	5.230896	5.320519	5.47201	5.049688	5.05549	5.109083	5.003274	5.300924	5.547221	5.42549	5.719851	5.597977	5.884889	5.917144	5.80973	5.789427	5.873313
4.209061	4.424109	4.57592	4.60562	4.551181	4.548646	4.596966	4.716511	4.810596	4.885941	4.850012	4.773245	4.829714	4.821782	4.666156	4.686667	4.762845	4.808313	4.532966	4.231437	4.423799	4.209061

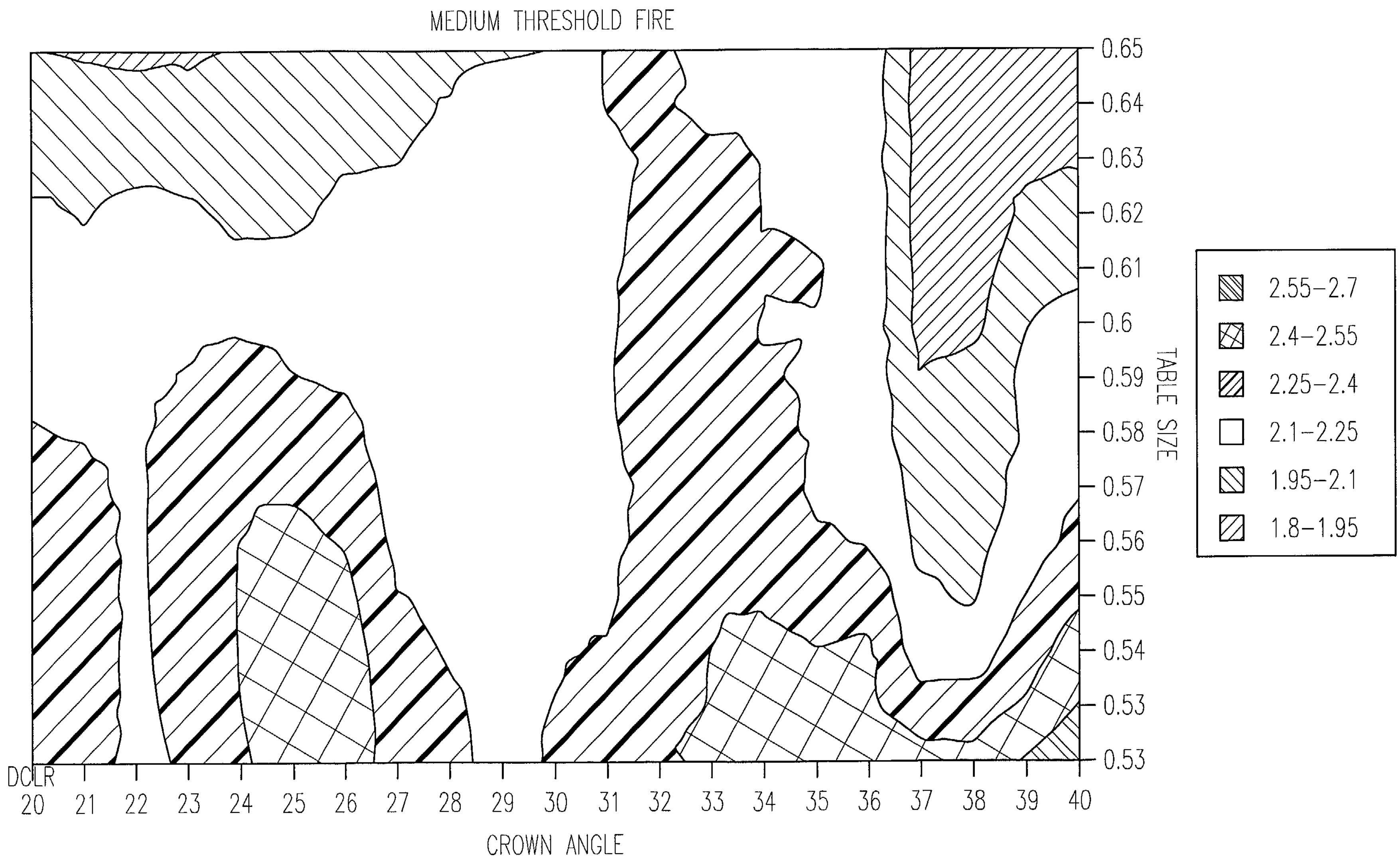
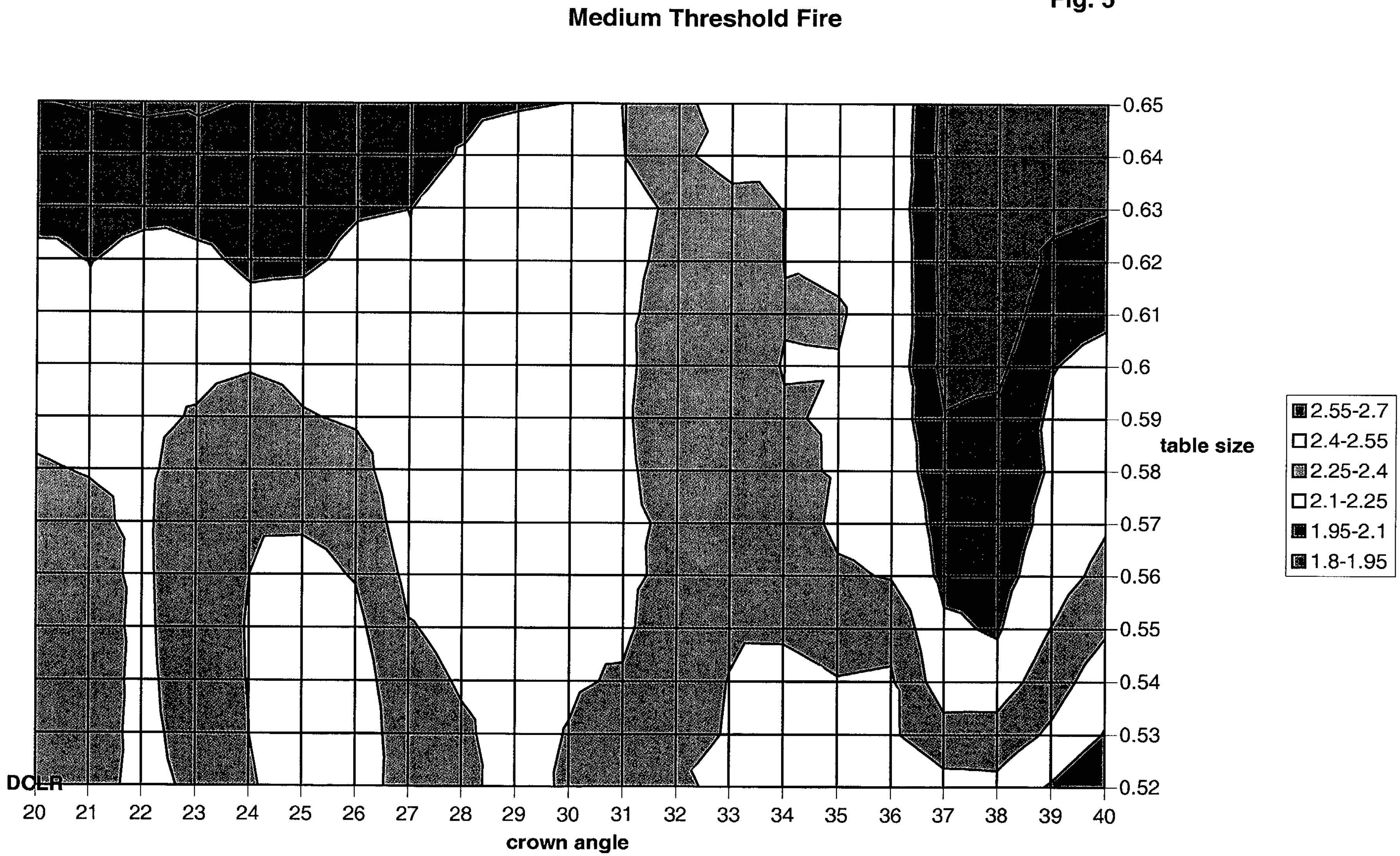

MEDIUM THRESHOLD FIRE
0.65
0.64
0.63
0.62
0.61
0.6
0.59
0.58
0.57
0.56
0.55
0.54
0.53
0.53
TABLE SIZE
DCLR
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
CROWN ANGLE
2.55–2.7
2.4–2.55
2.25–2.4
2.1–2.25
1.95–2.1
1.8–1.95

FIG. 5

Fig. 5


Medium Threshold Fire
DCLR
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
crown angle
0.65
0.64
0.63
0.62
0.61
0.6
0.59
0.58
0.57
0.56
0.55
0.54
0.53
0.52
table size
2.55-2.7
2.4-2.55
2.25-2.4
2.1-2.25
1.95-2.1
1.8-1.95

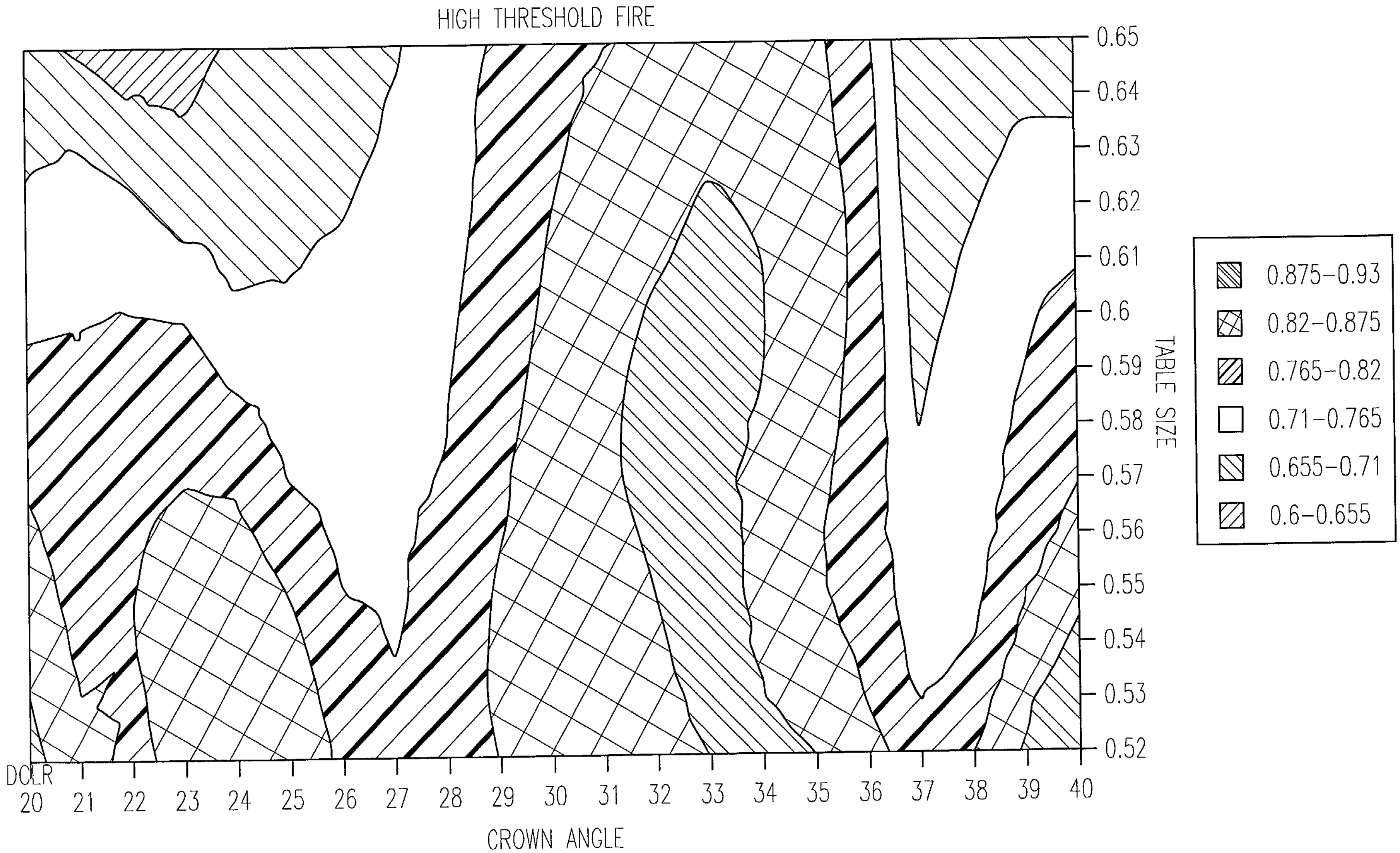
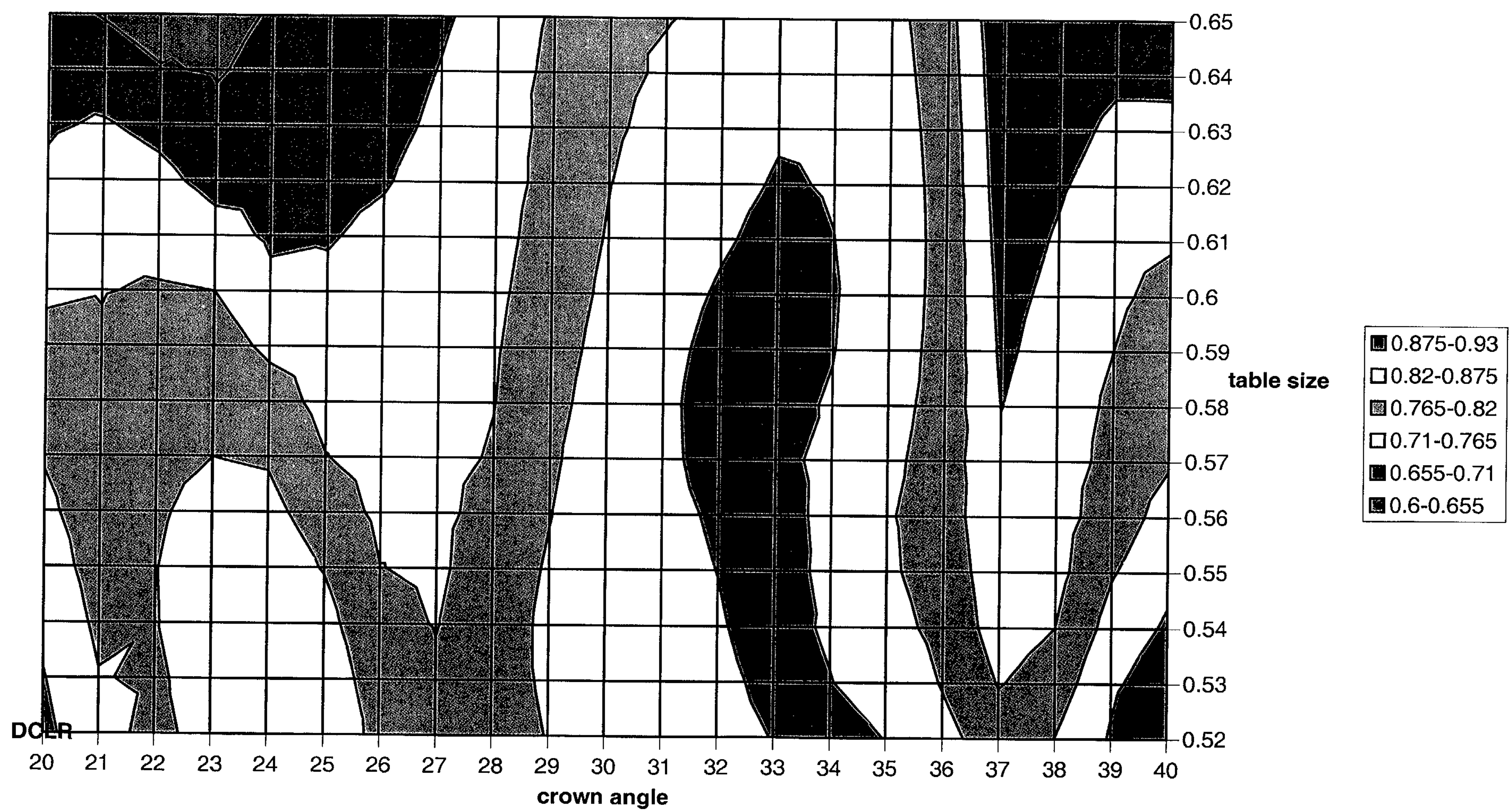

HIGH THRESHOLD FIRE
0.65
0.64
0.63
0.62
0.61
0.6
0.59
0.58
0.57
0.56
0.55
0.54
0.53
0.52
TABLE SIZE
DCLR
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
CROWN ANGLE
0.875–0.93
0.82–0.875
0.765–0.82
0.71–0.765
0.655–0.71
0.6–0.655

FIG. 6

Fig. 6

High Threshold Fire



DCLR (with reference to crown angle and table size) - Medium Threshold																					
Table Size																					
	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
0.52	0.889399	0.836137	0.80803	0.835899	0.843502	0.85091	0.809153	0.777319	0.778176	0.822632	0.843431	0.847797	0.861754	0.875922	0.884455	0.874472	0.83522	0.794012	0.820641	0.879217	0.925808
0.53	0.877923	0.822521	0.813364	0.838058	0.847552	0.848716	0.796386	0.771709	0.783916	0.830842	0.846235	0.850115	0.86672	0.883218	0.876516	0.856473	0.817092	0.762049	0.789167	0.867094	0.904074
0.54	0.864041	0.809538	0.818503	0.837076	0.847447	0.83708	0.779887	0.763208	0.790628	0.830807	0.845471	0.856028	0.87168	0.889323	0.869909	0.839013	0.805369	0.740686	0.765218	0.839051	0.883163
0.55	0.848831	0.798123	0.819221	0.833652	0.843494	0.817627	0.76589	0.757037	0.788203	0.825114	0.845811	0.86181	0.875469	0.891391	0.865573	0.828396	0.796559	0.733089	0.749023	0.816077	0.859523
0.56	0.832502	0.787851	0.816247	0.829484	0.833867	0.793886	0.753839	0.755395	0.77895	0.818271	0.847369	0.866889	0.87894	0.892496	0.863241	0.82614	0.788502	0.726241	0.742737	0.794879	0.838353
0.57	0.815732	0.779437	0.810141	0.819743	0.815161	0.766667	0.741619	0.752256	0.768499	0.812823	0.847118	0.870053	0.883652	0.887093	0.863287	0.833798	0.79141	0.718304	0.739348	0.781494	0.81613
0.58	0.797956	0.774204	0.800595	0.807438	0.789799	0.748017	0.732856	0.743976	0.764024	0.805049	0.844276	0.870545	0.884338	0.886611	0.871497	0.841303	0.796993	0.708974	0.737052	0.774727	0.798629
0.59	0.778568	0.770116	0.786796	0.790334	0.754238	0.733273	0.727433	0.738604	0.760982	0.796679	0.838495	0.867996	0.882911	0.888422	0.876342	0.847675	0.79937	0.701276	0.731596	0.765057	0.791944
0.6	0.75774	0.763044	0.769118	0.764915	0.721713	0.718529	0.722913	0.733238	0.756402	0.79058	0.830705	0.862142	0.878539	0.887673	0.877821	0.852095	0.800218	0.695151	0.723074	0.757208	0.779571
0.61	0.736879	0.752012	0.747005	0.729899	0.70267	0.7069	0.719931	0.728434	0.751028	0.785106	0.823538	0.853612	0.871361	0.884483	0.875527	0.853844	0.80037	0.68666	0.715178	0.747575	0.7609
0.62	0.718635	0.73586	0.723917	0.692448	0.686848	0.696845	0.706851	0.728386	0.747616	0.778597	0.818689	0.843502	0.86203	0.878854	0.872329	0.851574	0.798912	0.678443	0.705287	0.734623	0.742909
0.63	0.7046	0.71398	0.694854	0.667495	0.677278	0.68524	0.695101	0.720619	0.748032	0.775226	0.812894	0.834812	0.851162	0.871194	0.868553	0.84678	0.795258	0.671959	0.691424	0.721272	0.72133
0.64	0.690372	0.683461	0.658024	0.65122	0.668167	0.673809	0.684811	0.712404	0.74136	0.776011	0.808094	0.826394	0.838456	0.861151	0.863085	0.842193	0.788609	0.665847	0.677519	0.701312	0.700518
0.65	0.673199	0.650935	0.626648	0.642425	0.658586	0.663739	0.677502	0.703279	0.732282	0.771764	0.807634	0.818321	0.828758	0.847599	0.856115	0.836879	0.781369	0.657474	0.662932	0.677162	0.677832
0.925808	0.889399	0.836137	0.819221	0.838058	0.847552	0.85091	0.809153	0.777319	0.790628	0.830842	0.847369	0.870545	0.884338	0.892496	0.884455	0.874472	0.83522	0.794012	0.820641	0.879217	0.925808
0.626648	0.673199	0.650935	0.626648	0.642425	0.658586	0.663739	0.677502	0.703279	0.732282	0.771764	0.807634	0.818321	0.828758	0.847599	0.856115	0.82614	0.781369	0.657474	0.662932	0.677162	0.677832

DCLR (with reference to crown angle and table size) - High Threshold

Table Size	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
0.52	2.30223	2.335418	2.193281	2.28173	2.37404	2.507397	2.526301	2.292136	2.274878	2.213491	2.263117	2.318694	2.396675	2.404173	2.497725	2.465286	2.491756	2.44923	2.439982	2.564655	2.634142
0.53	2.304005	2.329233	2.206791	2.306826	2.39802	2.514777	2.509276	2.298946	2.263959	2.214281	2.254018	2.292316	2.357868	2.407772	2.482186	2.416049	2.418803	2.314221	2.3111	2.42419	2.558103
0.54	2.313594	2.324573	2.213602	2.324592	2.403448	2.508406	2.478646	2.285992	2.241246	2.210368	2.238267	2.258911	2.338892	2.402759	2.43167	2.406068	2.41833	2.163918	2.17034	2.336082	2.479787
0.55	2.309849	2.312501	2.220023	2.336642	2.405159	2.484451	2.438782	2.257812	2.216801	2.205081	2.230745	2.23362	2.307276	2.387627	2.386556	2.3448	2.355507	2.12493	2.084375	2.253937	2.383294
0.56	2.290357	2.294424	2.224495	2.33858	2.399793	2.441463	2.391322	2.216659	2.188527	2.183266	2.215199	2.227878	2.277004	2.352677	2.345421	2.266483	2.242278	2.064508	2.044293	2.184872	2.290029
0.57	2.271913	2.271483	2.227569	2.333174	2.383975	2.386016	2.351939	2.174897	2.168027	2.165533	2.209583	2.229816	2.269163	2.308357	2.313417	2.228194	2.211097	2.043476	2.015128	2.145181	2.237913
0.58	2.256496	2.245258	2.224163	2.304914	2.350532	2.314879	2.301797	2.145702	2.154863	2.149589	2.200822	2.236743	2.287629	2.271622	2.273146	2.240134	2.194433	1.999885	2.008567	2.113333	2.21557
0.59	2.232624	2.202266	2.212221	2.260972	2.311398	2.259275	2.232498	2.133239	2.144914	2.143788	2.186567	2.241172	2.295577	2.27709	2.257595	2.239302	2.189499	1.957835	1.984806	2.123774	2.162441
0.6	2.208264	2.159124	2.200003	2.212965	2.237939	2.210288	2.178597	2.131499	2.149113	2.144203	2.173946	2.236122	2.295137	2.289057	2.245972	2.247083	2.193257	1.904927	1.918563	2.095038	2.143703
0.61	2.173788	2.12016	2.173376	2.17039	2.13402	2.141835	2.149987	2.119507	2.155081	2.15407	2.155259	2.237656	2.28136	2.294391	2.254045	2.256015	2.216941	1.905148	1.861386	2.041885	2.078729
0.62	2.122214	2.096023	2.123691	2.127622	2.072749	2.078855	2.126691	2.105778	2.154286	2.170974	2.145525	2.232452	2.271611	2.292635	2.248172	2.237498	2.212457	1.896957	1.817691	1.987117	1.998415
0.63	2.06516	2.062477	2.080321	2.051564	2.025091	2.050181	2.090416	2.09862	2.127028	2.180911	2.147401	2.22679	2.264624	2.270502	2.248214	2.24508	2.19211	1.899925	1.823452	1.910596	1.942233
0.64	2.008445	2.013197	2.020619	1.992772	1.989728	2.045131	2.068072	2.069036	2.106709	2.147721	2.146403	2.251035	2.259674	2.227588	2.230171	2.245706	2.211771	1.881567	1.819499	1.889007	1.895533
0.65	1.955188	1.937305	1.918244	1.933478	1.958347	2.032557	2.061226	2.060949	2.075713	2.090885	2.101592	2.257497	2.276021	2.198133	2.193809	2.230203	2.219945	1.891284	1.826914	1.88438	1.869818
2.634142	2.313594	2.335418	2.227569	2.33858	2.405159	2.514777	2.526301	2.298946	2.274878	2.214281	2.263117	2.318694	2.396675	2.407772	2.497725	2.465286	2.491756	2.44923	2.439982	2.564655	2.634142
1.817691	1.955188	1.937305	1.918244	1.933478	1.958347	2.032557	2.061226	2.060949	2.075713	2.090885	2.101592	2.22679	2.259674	2.198133	2.193809	2.228194	2.189499	1.881567	1.817691	1.88438	1.869818

Fig. 7										
Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR4	*Wavelength* Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	40.5	0.56	0.005	0.3	0.75	0.03	64	5.611284	10	4
34	40.5	0.56	0.005	0.32	0.75	0.03	64	5.528535	10	4
34	40.5	0.56	0.005	0.34	0.75	0.03	64	5.467026	10	4
34	40.5	0.56	0.005	0.36	0.75	0.03	64	5.385497	10	4
34	40.5	0.56	0.005	0.38	0.75	0.03	64	5.397657	10	4
34	40.5	0.56	0.005	0.4	0.75	0.03	64	5.319126	10	4
34	40.5	0.56	0.005	0.42	0.75	0.03	64	5.248807	10	4
34	40.5	0.56	0.005	0.44	0.75	0.03	64	5.188517	10	4
34	40.5	0.56	0.005	0.46	0.75	0.03	64	5.181513	10	4
34	40.5	0.56	0.005	0.48	0.75	0.03	64	5.180843	10	4
34	40.5	0.56	0.005	0.5	0.75	0.03	64	5.266954	10	4
34	40.5	0.56	0.005	0.52	0.75	0.03	64	5.31061	10	4
34	40.5	0.56	0.005	0.54	0.75	0.03	64	5.406484	10	4
34	40.5	0.56	0.005	0.56	0.75	0.03	64	5.436373	10	4
34	40.5	0.56	0.005	0.58	0.75	0.03	64	5.363246	10	4
34	40.5	0.56	0.005	0.6	0.75	0.03	64	5.402035	10	4
34	40.5	0.56	0.005	0.62	0.75	0.03	64	5.429171	10	4
34	40.5	0.56	0.005	0.64	0.75	0.03	64	5.634116	10	4
34	40.5	0.56	0.005	0.66	0.75	0.03	64	5.597479	10	4
34	40.5	0.56	0.005	0.68	0.75	0.03	64	5.522144	10	4
34	40.5	0.56	0.005	0.7	0.75	0.03	64	5.515765	10	4
34	40.5	0.56	0.005	0.72	0.75	0.03	64	5.357773	10	4
34	40.5	0.56	0.005	0.74	0.75	0.03	64	5.125675	10	4
36	40.5	0.56	0.005	0.3	0.75	0.03	64	5.630651	10	4
36	40.5	0.56	0.005	0.32	0.75	0.03	64	5.69428	10	4
36	40.5	0.56	0.005	0.34	0.75	0.03	64	5.471578	10	4
36	40.5	0.56	0.005	0.36	0.75	0.03	64	5.358874	10	4
36	40.5	0.56	0.005	0.38	0.75	0.03	64	5.228163	10	4
36	40.5	0.56	0.005	0.4	0.75	0.03	64	5.153474	10	4
36	40.5	0.56	0.005	0.42	0.75	0.03	64	5.157299	10	4
36	40.5	0.56	0.005	0.44	0.75	0.03	64	5.179285	10	4
36	40.5	0.56	0.005	0.46	0.75	0.03	64	5.315996	10	4
36	40.5	0.56	0.005	0.48	0.75	0.03	64	5.207225	10	4
36	40.5	0.56	0.005	0.5	0.75	0.03	64	5.211515	10	4
36	40.5	0.56	0.005	0.52	0.75	0.03	64	5.397549	10	4
36	40.5	0.56	0.005	0.54	0.75	0.03	64	5.594171	10	4
36	40.5	0.56	0.005	0.56	0.75	0.03	64	5.689946	10	4
36	40.5	0.56	0.005	0.58	0.75	0.03	64	5.599288	10	4
36	40.5	0.56	0.005	0.6	0.75	0.03	64	5.653835	10	4
36	40.5	0.56	0.005	0.62	0.75	0.03	64	5.468048	10	4
36	40.5	0.56	0.005	0.64	0.75	0.03	64	5.337958	10	4
36	40.5	0.56	0.005	0.66	0.75	0.03	64	5.163907	10	4
36	40.5	0.56	0.005	0.68	0.75	0.03	64	5.061842	10	4
36	40.5	0.56	0.005	0.7	0.75	0.03	64	5.004612	10	4
36	40.5	0.56	0.005	0.72	0.75	0.03	64	4.839458	10	4
36	40.5	0.56	0.005	0.74	0.75	0.03	64	4.93131	10	4
25	40.5	0.56	0.005	0.3	0.75	0.03	64	5.041583	10	4
25	40.5	0.56	0.005	0.32	0.75	0.03	64	5.039889	10	4
25	40.5	0.56	0.005	0.34	0.75	0.03	64	5.014502	10	4
25	40.5	0.56	0.005	0.36	0.75	0.03	64	5.024592	10	4

Fig. 7

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR4	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
25	40.5	0.56	0.005	0.38	0.75	0.03	64	5.032936	10	4
25	40.5	0.56	0.005	0.4	0.75	0.03	64	5.082992	10	4
25	40.5	0.56	0.005	0.42	0.75	0.03	64	5.097746	10	4
25	40.5	0.56	0.005	0.44	0.75	0.03	64	5.136455	10	4
25	40.5	0.56	0.005	0.46	0.75	0.03	64	5.203904	10	4
25	40.5	0.56	0.005	0.48	0.75	0.03	64	5.248361	10	4
25	40.5	0.56	0.005	0.5	0.75	0.03	64	5.320519	10	4
25	40.5	0.56	0.005	0.52	0.75	0.03	64	5.363032	10	4
25	40.5	0.56	0.005	0.54	0.75	0.03	64	5.406238	10	4
25	40.5	0.56	0.005	0.56	0.75	0.03	64	5.367797	10	4
25	40.5	0.56	0.005	0.58	0.75	0.03	64	5.306217	10	4
25	40.5	0.56	0.005	0.6	0.75	0.03	64	5.252345	10	4
25	40.5	0.56	0.005	0.62	0.75	0.03	64	5.148876	10	4
25	40.5	0.56	0.005	0.64	0.75	0.03	64	5.025955	10	4
25	40.5	0.56	0.005	0.66	0.75	0.03	64	4.929556	10	4
25	40.5	0.56	0.005	0.68	0.75	0.03	64	4.894349	10	4
25	40.5	0.56	0.005	0.7	0.75	0.03	64	4.916253	10	4
25	40.5	0.56	0.005	0.72	0.75	0.03	64	4.820984	10	4
25	40.5	0.56	0.005	0.74	0.75	0.03	64	4.777098	10	4

Fig. 8

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR3	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	40.5	0.56	0.005	0.34	0.75	0.03	64	2.447601	10	3
34	40.5	0.56	0.005	0.36	0.75	0.03	64	2.373012	10	3
34	40.5	0.56	0.005	0.34	0.75	0.03	64	2.421435	10	3
34	40.5	0.56	0.005	0.36	0.75	0.03	64	2.45529	10	3
34	40.5	0.56	0.005	0.38	0.75	0.03	64	2.432463	10	3
34	40.5	0.56	0.005	0.4	0.75	0.03	64	2.400016	10	3
34	40.5	0.56	0.005	0.42	0.75	0.03	64	2.364763	10	3
34	40.5	0.56	0.005	0.44	0.75	0.03	64	2.33638	10	3
34	40.5	0.56	0.005	0.46	0.75	0.03	64	2.351346	10	3
34	40.5	0.56	0.005	0.48	0.75	0.03	64	2.35375	10	3
34	40.5	0.56	0.005	0.5	0.75	0.03	64	2.345421	10	3
34	40.5	0.56	0.005	0.52	0.75	0.03	64	2.348337	10	3
34	40.5	0.56	0.005	0.54	0.75	0.03	64	2.348061	10	3
34	40.5	0.56	0.005	0.56	0.75	0.03	64	2.349984	10	3
34	40.5	0.56	0.005	0.58	0.75	0.03	64	2.367726	10	3
34	40.5	0.56	0.005	0.6	0.75	0.03	64	2.397798	10	3
34	40.5	0.56	0.005	0.62	0.75	0.03	64	2.409934	10	3
34	40.5	0.56	0.005	0.64	0.75	0.03	64	2.413453	10	3
34	40.5	0.56	0.005	0.66	0.75	0.03	64	2.382642	10	3
34	40.5	0.56	0.005	0.68	0.75	0.03	64	2.374008	10	3
34	40.5	0.56	0.005	0.7	0.75	0.03	64	2.370136	10	3
34	40.5	0.56	0.005	0.72	0.75	0.03	64	2.338764	10	3
34	40.5	0.56	0.005	0.74	0.75	0.03	64	2.295892	10	3

Fig. 9

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thicknes s	# of Girdle Facets	DCLR2	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	40.5	0.56	0.005	0.3	0.75	0.03	64	0.811378	10	2
34	40.5	0.56	0.005	0.32	0.75	0.03	64	0.814937	10	2
34	40.5	0.56	0.005	0.34	0.75	0.03	64	0.833334	10	2
34	40.5	0.56	0.005	0.36	0.75	0.03	64	0.84361	10	2
34	40.5	0.56	0.005	0.38	0.75	0.03	64	0.844934	10	2
34	40.5	0.56	0.005	0.4	0.75	0.03	64	0.842936	10	2
34	40.5	0.56	0.005	0.42	0.75	0.03	64	0.844056	10	2
34	40.5	0.56	0.005	0.44	0.75	0.03	64	0.849681	10	2
34	40.5	0.56	0.005	0.46	0.75	0.03	64	0.85376	10	2
34	40.5	0.56	0.005	0.48	0.75	0.03	64	0.858143	10	2
34	40.5	0.56	0.005	0.5	0.75	0.03	64	0.863241	10	2
34	40.5	0.56	0.005	0.52	0.75	0.03	64	0.869004	10	2
34	40.5	0.56	0.005	0.54	0.75	0.03	64	0.874994	10	2
34	40.5	0.56	0.005	0.56	0.75	0.03	64	0.880953	10	2
34	40.5	0.56	0.005	0.58	0.75	0.03	64	0.885524	10	2
34	40.5	0.56	0.005	0.6	0.75	0.03	64	0.882234	10	2
34	40.5	0.56	0.005	0.62	0.75	0.03	64	0.871531	10	2
34	40.5	0.56	0.005	0.64	0.75	0.03	64	0.858103	10	2
34	40.5	0.56	0.005	0.66	0.75	0.03	64	0.84354	10	2
34	40.5	0.56	0.005	0.68	0.75	0.03	64	0.830189	10	2
34	40.5	0.56	0.005	0.7	0.75	0.03	64	0.825651	10	2
34	40.5	0.56	0.005	0.72	0.75	0.03	64	0.826947	10	2
34	40.5	0.56	0.005	0.74	0.75	0.03	64	0.827076	10	2

Fig. 10

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR4	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	38	0.52	0.005	0.5	0.75	0.03	64	5.493277	10	4
34	38.25	0.52	0.005	0.5	0.75	0.03	64	5.805845	10	4
34	38.5	0.52	0.005	0.5	0.75	0.03	64	5.942586	10	4
34	38.75	0.52	0.005	0.5	0.75	0.03	64	5.73637	10	4
34	39	0.52	0.005	0.5	0.75	0.03	64	5.420115	10	4
34	39.25	0.52	0.005	0.5	0.75	0.03	64	5.73459	10	4
34	39.5	0.52	0.005	0.5	0.75	0.03	64	5.727515	10	4
34	39.75	0.52	0.005	0.5	0.75	0.03	64	5.530222	10	4
34	40	0.52	0.005	0.5	0.75	0.03	64	5.438755	10	4
34	40.25	0.52	0.005	0.5	0.75	0.03	64	5.609786	10	4
34	40.5	0.52	0.005	0.5	0.75	0.03	64	5.719851	10	4
34	40.75	0.52	0.005	0.5	0.75	0.03	64	5.513499	10	4
34	41	0.52	0.005	0.5	0.75	0.03	64	5.717267	10	4
34	41.25	0.52	0.005	0.5	0.75	0.03	64	5.499554	10	4
34	41.5	0.52	0.005	0.5	0.75	0.03	64	5.133205	10	4
34	41.75	0.52	0.005	0.5	0.75	0.03	64	4.903186	10	4
34	42	0.52	0.005	0.5	0.75	0.03	64	4.680863	10	4
34	42.25	0.52	0.005	0.5	0.75	0.03	64	4.548648	10	4
34	42.5	0.52	0.005	0.5	0.75	0.03	64	4.545021	10	4
34	42.75	0.52	0.005	0.5	0.75	0.03	64	4.067325	10	4
34	43	0.52	0.005	0.5	0.75	0.03	64	3.921024	10	4
34	38	0.53	0.005	0.5	0.75	0.03	64	5.717495	10	4
34	38.25	0.53	0.005	0.5	0.75	0.03	64	5.810591	10	4
34	38.5	0.53	0.005	0.5	0.75	0.03	64	5.926244	10	4
34	38.75	0.53	0.005	0.5	0.75	0.03	64	5.767832	10	4
34	39	0.53	0.005	0.5	0.75	0.03	64	5.419467	10	4
34	39.25	0.53	0.005	0.5	0.75	0.03	64	5.689173	10	4
34	39.5	0.53	0.005	0.5	0.75	0.03	64	5.611356	10	4
34	39.75	0.53	0.005	0.5	0.75	0.03	64	5.348584	10	4
34	40	0.53	0.005	0.5	0.75	0.03	64	5.371505	10	4
34	40.25	0.53	0.005	0.5	0.75	0.03	64	5.571745	10	4
34	40.5	0.53	0.005	0.5	0.75	0.03	64	5.667448	10	4
34	40.75	0.53	0.005	0.5	0.75	0.03	64	5.597261	10	4
34	41	0.53	0.005	0.5	0.75	0.03	64	5.578154	10	4
34	41.25	0.53	0.005	0.5	0.75	0.03	64	5.412163	10	4
34	41.5	0.53	0.005	0.5	0.75	0.03	64	5.049304	10	4
34	41.75	0.53	0.005	0.5	0.75	0.03	64	4.730424	10	4
34	42	0.53	0.005	0.5	0.75	0.03	64	4.570047	10	4
34	42.25	0.53	0.005	0.5	0.75	0.03	64	4.523695	10	4
34	42.5	0.53	0.005	0.5	0.75	0.03	64	4.477343	10	4
34	42.75	0.53	0.005	0.5	0.75	0.03	64	4.037887	10	4
34	43	0.53	0.005	0.5	0.75	0.03	64	3.877986	10	4
34	38	0.54	0.005	0.5	0.75	0.03	64	5.622371	10	4
34	38.25	0.54	0.005	0.5	0.75	0.03	64	5.678961	10	4
34	38.5	0.54	0.005	0.5	0.75	0.03	64	5.899668	10	4
34	38.75	0.54	0.005	0.5	0.75	0.03	64	5.757424	10	4
34	39	0.54	0.005	0.5	0.75	0.03	64	5.423527	10	4
34	39.25	0.54	0.005	0.5	0.75	0.03	64	5.53263	10	4
34	39.5	0.54	0.005	0.5	0.75	0.03	64	5.568131	10	4
34	39.75	0.54	0.005	0.5	0.75	0.03	64	5.343607	10	4
34	40	0.54	0.005	0.5	0.75	0.03	64	5.178168	10	4
34	40.25	0.54	0.005	0.5	0.75	0.03	64	5.312555	10	4
34	40.5	0.54	0.005	0.5	0.75	0.03	64	5.599147	10	4
34	40.75	0.54	0.005	0.5	0.75	0.03	64	5.426709	10	4
34	41	0.54	0.005	0.5	0.75	0.03	64	5.405064	10	4
34	41.25	0.54	0.005	0.5	0.75	0.03	64	5.213119	10	4

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR4	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	41.5	0.54	0.005	0.5	0.75	0.03	64	5.003045	10	4
34	41.75	0.54	0.005	0.5	0.75	0.03	64	4.623531	10	4
34	42	0.54	0.005	0.5	0.75	0.03	64	4.533406	10	4
34	42.25	0.54	0.005	0.5	0.75	0.03	64	4.463817	10	4
34	42.5	0.54	0.005	0.5	0.75	0.03	64	4.334422	10	4
34	42.75	0.54	0.005	0.5	0.75	0.03	64	4.030265	10	4
34	43	0.54	0.005	0.5	0.75	0.03	64	3.937283	10	4
34	38	0.55	0.005	0.5	0.75	0.03	64	5.424596	10	4
34	38.25	0.55	0.005	0.5	0.75	0.03	64	5.596816	10	4
34	38.5	0.55	0.005	0.5	0.75	0.03	64	5.822916	10	4
34	38.75	0.55	0.005	0.5	0.75	0.03	64	5.775823	10	4
34	39	0.55	0.005	0.5	0.75	0.03	64	5.481692	10	4
34	39.25	0.55	0.005	0.5	0.75	0.03	64	5.450962	10	4
34	39.5	0.55	0.005	0.5	0.75	0.03	64	5.513478	10	4
34	39.75	0.55	0.005	0.5	0.75	0.03	64	5.417895	10	4
34	40	0.55	0.005	0.5	0.75	0.03	64	5.030628	10	4
34	40.25	0.55	0.005	0.5	0.75	0.03	64	5.182121	10	4
34	40.5	0.55	0.005	0.5	0.75	0.03	64	5.428893	10	4
34	40.75	0.55	0.005	0.5	0.75	0.03	64	5.329691	10	4
34	41	0.55	0.005	0.5	0.75	0.03	64	5.289889	10	4
34	41.25	0.55	0.005	0.5	0.75	0.03	64	5.129013	10	4
34	41.5	0.55	0.005	0.5	0.75	0.03	64	4.885418	10	4
34	41.75	0.55	0.005	0.5	0.75	0.03	64	4.483177	10	4
34	42	0.55	0.005	0.5	0.75	0.03	64	4.452805	10	4
34	42.25	0.55	0.005	0.5	0.75	0.03	64	4.434488	10	4
34	42.5	0.55	0.005	0.5	0.75	0.03	64	4.301845	10	4
34	42.75	0.55	0.005	0.5	0.75	0.03	64	3.988017	10	4
34	43	0.55	0.005	0.5	0.75	0.03	64	3.892357	10	4
34	38	0.56	0.005	0.5	0.75	0.03	64	5.229829	10	4
34	38.25	0.56	0.005	0.5	0.75	0.03	64	5.453779	10	4
34	38.5	0.56	0.005	0.5	0.75	0.03	64	5.638591	10	4
34	38.75	0.56	0.005	0.5	0.75	0.03	64	5.765021	10	4
34	39	0.56	0.005	0.5	0.75	0.03	64	5.596684	10	4
34	39.25	0.56	0.005	0.5	0.75	0.03	64	5.353917	10	4
34	39.5	0.56	0.005	0.5	0.75	0.03	64	5.401111	10	4
34	39.75	0.56	0.005	0.5	0.75	0.03	64	5.414612	10	4
34	40	0.56	0.005	0.5	0.75	0.03	64	5.133628	10	4
34	40.25	0.56	0.005	0.5	0.75	0.03	64	5.105611	10	4
34	40.5	0.56	0.005	0.5	0.75	0.03	64	5.266954	10	4
34	40.75	0.56	0.005	0.5	0.75	0.03	64	5.197605	10	4
34	41	0.56	0.005	0.5	0.75	0.03	64	5.132326	10	4
34	41.25	0.56	0.005	0.5	0.75	0.03	64	5.000269	10	4
34	41.5	0.56	0.005	0.5	0.75	0.03	64	4.728625	10	4
34	41.75	0.56	0.005	0.5	0.75	0.03	64	4.471355	10	4
34	42	0.56	0.005	0.5	0.75	0.03	64	4.42342	10	4
34	42.25	0.56	0.005	0.5	0.75	0.03	64	4.461586	10	4
34	42.5	0.56	0.005	0.5	0.75	0.03	64	4.302394	10	4
34	42.75	0.56	0.005	0.5	0.75	0.03	64	3.9399	10	4
34	43	0.56	0.005	0.5	0.75	0.03	64	3.803905	10	4
34	38	0.57	0.005	0.5	0.75	0.03	64	4.93232	10	4
34	38.25	0.57	0.005	0.5	0.75	0.03	64	5.206947	10	4
34	38.5	0.57	0.005	0.5	0.75	0.03	64	5.572394	10	4
34	38.75	0.57	0.005	0.5	0.75	0.03	64	5.652302	10	4
34	39	0.57	0.005	0.5	0.75	0.03	64	5.555333	10	4
34	39.25	0.57	0.005	0.5	0.75	0.03	64	5.316009	10	4
34	39.5	0.57	0.005	0.5	0.75	0.03	64	5.300094	10	4
34	39.75	0.57	0.005	0.5	0.75	0.03	64	5.397194	10	4

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR4	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	40	0.57	0.005	0.5	0.75	0.03	64	5.075396	10	4
34	40.25	0.57	0.005	0.5	0.75	0.03	64	4.959463	10	4
34	40.5	0.57	0.005	0.5	0.75	0.03	64	5.037557	10	4
34	40.75	0.57	0.005	0.5	0.75	0.03	64	5.096533	10	4
34	41	0.57	0.005	0.5	0.75	0.03	64	5.018315	10	4
34	41.25	0.57	0.005	0.5	0.75	0.03	64	4.968305	10	4
34	41.5	0.57	0.005	0.5	0.75	0.03	64	4.764407	10	4
34	41.75	0.57	0.005	0.5	0.75	0.03	64	4.485349	10	4
34	42	0.57	0.005	0.5	0.75	0.03	64	4.321794	10	4
34	42.25	0.57	0.005	0.5	0.75	0.03	64	4.463833	10	4
34	42.5	0.57	0.005	0.5	0.75	0.03	64	4.288975	10	4
34	42.75	0.57	0.005	0.5	0.75	0.03	64	3.89191	10	4
34	43	0.57	0.005	0.5	0.75	0.03	64	3.668917	10	4
34	38	0.58	0.005	0.5	0.75	0.03	64	4.89769	10	4
34	38.25	0.58	0.005	0.5	0.75	0.03	64	4.905187	10	4
34	38.5	0.58	0.005	0.5	0.75	0.03	64	5.405338	10	4
34	38.75	0.58	0.005	0.5	0.75	0.03	64	5.604507	10	4
34	39	0.58	0.005	0.5	0.75	0.03	64	5.424502	10	4
34	39.25	0.58	0.005	0.5	0.75	0.03	64	5.229388	10	4
34	39.5	0.58	0.005	0.5	0.75	0.03	64	5.147347	10	4
34	39.75	0.58	0.005	0.5	0.75	0.03	64	5.314294	10	4
34	40	0.58	0.005	0.5	0.75	0.03	64	5.018439	10	4
34	40.25	0.58	0.005	0.5	0.75	0.03	64	4.792406	10	4
34	40.5	0.58	0.005	0.5	0.75	0.03	64	4.934068	10	4
34	40.75	0.58	0.005	0.5	0.75	0.03	64	5.085083	10	4
34	41	0.58	0.005	0.5	0.75	0.03	64	5.018061	10	4
34	41.25	0.58	0.005	0.5	0.75	0.03	64	4.944051	10	4
34	41.5	0.58	0.005	0.5	0.75	0.03	64	4.762533	10	4
34	41.75	0.58	0.005	0.5	0.75	0.03	64	4.439249	10	4
34	42	0.58	0.005	0.5	0.75	0.03	64	4.266388	10	4
34	42.25	0.58	0.005	0.5	0.75	0.03	64	4.453432	10	4
34	42.5	0.58	0.005	0.5	0.75	0.03	64	4.314914	10	4
34	42.75	0.58	0.005	0.5	0.75	0.03	64	3.875559	10	4
34	43	0.58	0.005	0.5	0.75	0.03	64	3.538107	10	4
34	38	0.59	0.005	0.5	0.75	0.03	64	4.842274	10	4
34	38.25	0.59	0.005	0.5	0.75	0.03	64	4.754307	10	4
34	38.5	0.59	0.005	0.5	0.75	0.03	64	5.221967	10	4
34	38.75	0.59	0.005	0.5	0.75	0.03	64	5.33594	10	4
34	39	0.59	0.005	0.5	0.75	0.03	64	5.314924	10	4
34	39.25	0.59	0.005	0.5	0.75	0.03	64	5.222291	10	4
34	39.5	0.59	0.005	0.5	0.75	0.03	64	5.142299	10	4
34	39.75	0.59	0.005	0.5	0.75	0.03	64	5.242247	10	4
34	40	0.59	0.005	0.5	0.75	0.03	64	5.068558	10	4
34	40.25	0.59	0.005	0.5	0.75	0.03	64	4.801819	10	4
34	40.5	0.59	0.005	0.5	0.75	0.03	64	4.934716	10	4
34	40.75	0.59	0.005	0.5	0.75	0.03	64	5.041384	10	4
34	41	0.59	0.005	0.5	0.75	0.03	64	4.98427	10	4
34	41.25	0.59	0.005	0.5	0.75	0.03	64	4.963404	10	4
34	41.5	0.59	0.005	0.5	0.75	0.03	64	4.643272	10	4
34	41.75	0.59	0.005	0.5	0.75	0.03	64	4.387925	10	4
34	42	0.59	0.005	0.5	0.75	0.03	64	4.273769	10	4
34	42.25	0.59	0.005	0.5	0.75	0.03	64	4.367913	10	4
34	42.5	0.59	0.005	0.5	0.75	0.03	64	4.212573	10	4
34	42.75	0.59	0.005	0.5	0.75	0.03	64	3.891038	10	4
34	43	0.59	0.005	0.5	0.75	0.03	64	3.563555	10	4
34	38	0.6	0.005	0.5	0.75	0.03	64	4.673238	10	4
34	38.25	0.6	0.005	0.5	0.75	0.03	64	4.599346	10	4

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR4	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	38.5	0.6	0.005	0.5	0.75	0.03	64	5.071326	10	4
34	38.75	0.6	0.005	0.5	0.75	0.03	64	5.183723	10	4
34	39	0.6	0.005	0.5	0.75	0.03	64	5.199297	10	4
34	39.25	0.6	0.005	0.5	0.75	0.03	64	5.275915	10	4
34	39.5	0.6	0.005	0.5	0.75	0.03	64	5.193584	10	4
34	39.75	0.6	0.005	0.5	0.75	0.03	64	5.247627	10	4
34	40	0.6	0.005	0.5	0.75	0.03	64	5.072312	10	4
34	40.25	0.6	0.005	0.5	0.75	0.03	64	4.781289	10	4
34	40.5	0.6	0.005	0.5	0.75	0.03	64	4.923382	10	4
34	40.75	0.6	0.005	0.5	0.75	0.03	64	4.944674	10	4
34	41	0.6	0.005	0.5	0.75	0.03	64	4.937654	10	4
34	41.25	0.6	0.005	0.5	0.75	0.03	64	4.927164	10	4
34	41.5	0.6	0.005	0.5	0.75	0.03	64	4.719866	10	4
34	41.75	0.6	0.005	0.5	0.75	0.03	64	4.510105	10	4
34	42	0.6	0.005	0.5	0.75	0.03	64	4.272734	10	4
34	42.25	0.6	0.005	0.5	0.75	0.03	64	4.187286	10	4
34	42.5	0.6	0.005	0.5	0.75	0.03	64	4.043926	10	4
34	42.75	0.6	0.005	0.5	0.75	0.03	64	3.776883	10	4
34	43	0.6	0.005	0.5	0.75	0.03	64	3.517216	10	4
34	38	0.61	0.005	0.5	0.75	0.03	64	4.572618	10	4
34	38.25	0.61	0.005	0.5	0.75	0.03	64	4.673075	10	4
34	38.5	0.61	0.005	0.5	0.75	0.03	64	4.964236	10	4
34	38.75	0.61	0.005	0.5	0.75	0.03	64	5.096562	10	4
34	39	0.61	0.005	0.5	0.75	0.03	64	5.010287	10	4
34	39.25	0.61	0.005	0.5	0.75	0.03	64	5.289823	10	4
34	39.5	0.61	0.005	0.5	0.75	0.03	64	5.250743	10	4
34	39.75	0.61	0.005	0.5	0.75	0.03	64	5.196805	10	4
34	40	0.61	0.005	0.5	0.75	0.03	64	5.017651	10	4
34	40.25	0.61	0.005	0.5	0.75	0.03	64	4.822792	10	4
34	40.5	0.61	0.005	0.5	0.75	0.03	64	4.922016	10	4
34	40.75	0.61	0.005	0.5	0.75	0.03	64	4.878578	10	4
34	41	0.61	0.005	0.5	0.75	0.03	64	4.981758	10	4
34	41.25	0.61	0.005	0.5	0.75	0.03	64	4.88136	10	4
34	41.5	0.61	0.005	0.5	0.75	0.03	64	4.704769	10	4
34	41.75	0.61	0.005	0.5	0.75	0.03	64	4.559749	10	4
34	42	0.61	0.005	0.5	0.75	0.03	64	4.312059	10	4
34	42.25	0.61	0.005	0.5	0.75	0.03	64	4.041883	10	4
34	42.5	0.61	0.005	0.5	0.75	0.03	64	3.906976	10	4
34	42.75	0.61	0.005	0.5	0.75	0.03	64	3.607952	10	4
34	43	0.61	0.005	0.5	0.75	0.03	64	3.397672	10	4
34	38	0.62	0.005	0.5	0.75	0.03	64	4.431196	10	4
34	38.25	0.62	0.005	0.5	0.75	0.03	64	4.711157	10	4
34	38.5	0.62	0.005	0.5	0.75	0.03	64	4.79142	10	4
34	38.75	0.62	0.005	0.5	0.75	0.03	64	5.107477	10	4
34	39	0.62	0.005	0.5	0.75	0.03	64	4.948804	10	4
34	39.25	0.62	0.005	0.5	0.75	0.03	64	5.242472	10	4
34	39.5	0.62	0.005	0.5	0.75	0.03	64	5.308088	10	4
34	39.75	0.62	0.005	0.5	0.75	0.03	64	5.208467	10	4
34	40	0.62	0.005	0.5	0.75	0.03	64	4.939575	10	4
34	40.25	0.62	0.005	0.5	0.75	0.03	64	4.79219	10	4
34	40.5	0.62	0.005	0.5	0.75	0.03	64	4.819245	10	4
34	40.75	0.62	0.005	0.5	0.75	0.03	64	4.834752	10	4
34	41	0.62	0.005	0.5	0.75	0.03	64	4.86977	10	4
34	41.25	0.62	0.005	0.5	0.75	0.03	64	4.779608	10	4
34	41.5	0.62	0.005	0.5	0.75	0.03	64	4.717905	10	4
34	41.75	0.62	0.005	0.5	0.75	0.03	64	4.5101	10	4
34	42	0.62	0.005	0.5	0.75	0.03	64	4.294812	10	4

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR4	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	42.25	0.62	0.005	0.5	0.75	0.03	64	4.041671	10	4
34	42.5	0.62	0.005	0.5	0.75	0.03	64	3.845437	10	4
34	42.75	0.62	0.005	0.5	0.75	0.03	64	3.488905	10	4
34	43	0.62	0.005	0.5	0.75	0.03	64	3.245714	10	4
34	38	0.63	0.005	0.5	0.75	0.03	64	4.444624	10	4
34	38.25	0.63	0.005	0.5	0.75	0.03	64	4.707872	10	4
34	38.5	0.63	0.005	0.5	0.75	0.03	64	4.712884	10	4
34	38.75	0.63	0.005	0.5	0.75	0.03	64	4.997234	10	4
34	39	0.63	0.005	0.5	0.75	0.03	64	4.976386	10	4
34	39.25	0.63	0.005	0.5	0.75	0.03	64	5.241674	10	4
34	39.5	0.63	0.005	0.5	0.75	0.03	64	5.337666	10	4
34	39.75	0.63	0.005	0.5	0.75	0.03	64	5.1678	10	4
34	40	0.63	0.005	0.5	0.75	0.03	64	4.868893	10	4
34	40.25	0.63	0.005	0.5	0.75	0.03	64	4.738868	10	4
34	40.5	0.63	0.005	0.5	0.75	0.03	64	4.80074	10	4
34	40.75	0.63	0.005	0.5	0.75	0.03	64	4.89628	10	4
34	41	0.63	0.005	0.5	0.75	0.03	64	4.779172	10	4
34	41.25	0.63	0.005	0.5	0.75	0.03	64	4.772348	10	4
34	41.5	0.63	0.005	0.5	0.75	0.03	64	4.665951	10	4
34	41.75	0.63	0.005	0.5	0.75	0.03	64	4.491212	10	4
34	42	0.63	0.005	0.5	0.75	0.03	64	4.2586	10	4
34	42.25	0.63	0.005	0.5	0.75	0.03	64	3.949061	10	4
34	42.5	0.63	0.005	0.5	0.75	0.03	64	3.749323	10	4
34	42.75	0.63	0.005	0.5	0.75	0.03	64	3.367393	10	4
34	43	0.63	0.005	0.5	0.75	0.03	64	3.175437	10	4
34	38	0.64	0.005	0.5	0.75	0.03	64	4.375601	10	4
34	38.25	0.64	0.005	0.5	0.75	0.03	64	4.653965	10	4
34	38.5	0.64	0.005	0.5	0.75	0.03	64	4.851339	10	4
34	38.75	0.64	0.005	0.5	0.75	0.03	64	4.910555	10	4
34	39	0.64	0.005	0.5	0.75	0.03	64	4.890862	10	4
34	39.25	0.64	0.005	0.5	0.75	0.03	64	5.230752	10	4
34	39.5	0.64	0.005	0.5	0.75	0.03	64	5.237599	10	4
34	39.75	0.64	0.005	0.5	0.75	0.03	64	5.154108	10	4
34	40	0.64	0.005	0.5	0.75	0.03	64	4.799762	10	4
34	40.25	0.64	0.005	0.5	0.75	0.03	64	4.806213	10	4
34	40.5	0.64	0.005	0.5	0.75	0.03	64	4.76932	10	4
34	40.75	0.64	0.005	0.5	0.75	0.03	64	4.762513	10	4
34	41	0.64	0.005	0.5	0.75	0.03	64	4.830222	10	4
34	41.25	0.64	0.005	0.5	0.75	0.03	64	4.644581	10	4
34	41.5	0.64	0.005	0.5	0.75	0.03	64	4.584929	10	4
34	41.75	0.64	0.005	0.5	0.75	0.03	64	4.363803	10	4
34	42	0.64	0.005	0.5	0.75	0.03	64	4.284305	10	4
34	42.25	0.64	0.005	0.5	0.75	0.03	64	3.78676	10	4
34	42.5	0.64	0.005	0.5	0.75	0.03	64	3.684077	10	4
34	42.75	0.64	0.005	0.5	0.75	0.03	64	3.192547	10	4
34	43	0.64	0.005	0.5	0.75	0.03	64	3.3293	10	4
34	38	0.65	0.005	0.5	0.75	0.03	64	4.213167	10	4
34	38.25	0.65	0.005	0.5	0.75	0.03	64	4.606747	10	4
34	38.5	0.65	0.005	0.5	0.75	0.03	64	4.887867	10	4
34	38.75	0.65	0.005	0.5	0.75	0.03	64	4.792631	10	4
34	39	0.65	0.005	0.5	0.75	0.03	64	4.895459	10	4
34	39.25	0.65	0.005	0.5	0.75	0.03	64	5.234235	10	4
34	39.5	0.65	0.005	0.5	0.75	0.03	64	5.261138	10	4
34	39.75	0.65	0.005	0.5	0.75	0.03	64	5.383435	10	4
34	40	0.65	0.005	0.5	0.75	0.03	64	4.753519	10	4
34	40.25	0.65	0.005	0.5	0.75	0.03	64	4.761221	10	4
34	40.5	0.65	0.005	0.5	0.75	0.03	64	4.686667	10	4

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR4	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	40.75	0.65	0.005	0.5	0.75	0.03	64	4.722319	10	4
34	41	0.65	0.005	0.5	0.75	0.03	64	4.880547	10	4
34	41.25	0.65	0.005	0.5	0.75	0.03	64	4.640121	10	4
34	41.5	0.65	0.005	0.5	0.75	0.03	64	4.50616	10	4
34	41.75	0.65	0.005	0.5	0.75	0.03	64	4.242882	10	4
34	42	0.65	0.005	0.5	0.75	0.03	64	4.070292	10	4
34	42.25	0.65	0.005	0.5	0.75	0.03	64	3.746429	10	4
34	42.5	0.65	0.005	0.5	0.75	0.03	64	3.579245	10	4
34	42.75	0.65	0.005	0.5	0.75	0.03	64	3.103817	10	4
34	43	0.65	0.005	0.5	0.75	0.03	64	3.192281	10	4

Fig. 11

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR3	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	38	0.52	0.005	0.5	0.75	0.03	64	2.56024	10	3
34	38.25	0.52	0.005	0.5	0.75	0.03	64	2.62372	10	3
34	38.5	0.52	0.005	0.5	0.75	0.03	64	2.637903	10	3
34	38.75	0.52	0.005	0.5	0.75	0.03	64	2.45408	10	3
34	39	0.52	0.005	0.5	0.75	0.03	64	2.521807	10	3
34	39.25	0.52	0.005	0.5	0.75	0.03	64	2.628378	10	3
34	39.5	0.52	0.005	0.5	0.75	0.03	64	2.586273	10	3
34	39.75	0.52	0.005	0.5	0.75	0.03	64	2.484274	10	3
34	40	0.52	0.005	0.5	0.75	0.03	64	2.42121	10	3
34	40.25	0.52	0.005	0.5	0.75	0.03	64	2.502591	10	3
34	40.5	0.52	0.005	0.5	0.75	0.03	64	2.497725	10	3
34	40.75	0.52	0.005	0.5	0.75	0.03	64	2.402551	10	3
34	41	0.52	0.005	0.5	0.75	0.03	64	2.495177	10	3
34	41.25	0.52	0.005	0.5	0.75	0.03	64	2.304985	10	3
34	41.5	0.52	0.005	0.5	0.75	0.03	64	2.216605	10	3
34	41.75	0.52	0.005	0.5	0.75	0.03	64	2.158096	10	3
34	42	0.52	0.005	0.5	0.75	0.03	64	2.069741	10	3
34	42.25	0.52	0.005	0.5	0.75	0.03	64	1.949909	10	3
34	42.5	0.52	0.005	0.5	0.75	0.03	64	1.922056	10	3
34	42.75	0.52	0.005	0.5	0.75	0.03	64	1.772726	10	3
34	43	0.52	0.005	0.5	0.75	0.03	64	1.751846	10	3
34	38	0.53	0.005	0.5	0.75	0.03	64	2.585623	10	3
34	38.25	0.53	0.005	0.5	0.75	0.03	64	2.631226	10	3
34	38.5	0.53	0.005	0.5	0.75	0.03	64	2.607705	10	3
34	38.75	0.53	0.005	0.5	0.75	0.03	64	2.489197	10	3
34	39	0.53	0.005	0.5	0.75	0.03	64	2.505629	10	3
34	39.25	0.53	0.005	0.5	0.75	0.03	64	2.577766	10	3
34	39.5	0.53	0.005	0.5	0.75	0.03	64	2.554002	10	3
34	39.75	0.53	0.005	0.5	0.75	0.03	64	2.451161	10	3
34	40	0.53	0.005	0.5	0.75	0.03	64	2.387227	10	3
34	40.25	0.53	0.005	0.5	0.75	0.03	64	2.465355	10	3
34	40.5	0.53	0.005	0.5	0.75	0.03	64	2.482186	10	3
34	40.75	0.53	0.005	0.5	0.75	0.03	64	2.397814	10	3
34	41	0.53	0.005	0.5	0.75	0.03	64	2.405243	10	3
34	41.25	0.53	0.005	0.5	0.75	0.03	64	2.219772	10	3
34	41.5	0.53	0.005	0.5	0.75	0.03	64	2.159837	10	3
34	41.75	0.53	0.005	0.5	0.75	0.03	64	2.109897	10	3
34	42	0.53	0.005	0.5	0.75	0.03	64	2.01383	10	3
34	42.25	0.53	0.005	0.5	0.75	0.03	64	1.911171	10	3
34	42.5	0.53	0.005	0.5	0.75	0.03	64	1.856773	10	3
34	42.75	0.53	0.005	0.5	0.75	0.03	64	1.709568	10	3
34	43	0.53	0.005	0.5	0.75	0.03	64	1.712729	10	3
34	38	0.54	0.005	0.5	0.75	0.03	64	2.558642	10	3
34	38.25	0.54	0.005	0.5	0.75	0.03	64	2.602757	10	3
34	38.5	0.54	0.005	0.5	0.75	0.03	64	2.572777	10	3
34	38.75	0.54	0.005	0.5	0.75	0.03	64	2.497193	10	3
34	39	0.54	0.005	0.5	0.75	0.03	64	2.485891	10	3
34	39.25	0.54	0.005	0.5	0.75	0.03	64	2.529724	10	3
34	39.5	0.54	0.005	0.5	0.75	0.03	64	2.520005	10	3
34	39.75	0.54	0.005	0.5	0.75	0.03	64	2.430968	10	3
34	40	0.54	0.005	0.5	0.75	0.03	64	2.373474	10	3
34	40.25	0.54	0.005	0.5	0.75	0.03	64	2.42504	10	3

Fig. 11

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR3	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	40.5	0.54	0.005	0.5	0.75	0.03	64	2.43167	10	3
34	40.75	0.54	0.005	0.5	0.75	0.03	64	2.362006	10	3
34	41	0.54	0.005	0.5	0.75	0.03	64	2.362826	10	3
34	41.25	0.54	0.005	0.5	0.75	0.03	64	2.151353	10	3
34	41.5	0.54	0.005	0.5	0.75	0.03	64	2.097091	10	3
34	41.75	0.54	0.005	0.5	0.75	0.03	64	2.055188	10	3
34	42	0.54	0.005	0.5	0.75	0.03	64	1.974824	10	3
34	42.25	0.54	0.005	0.5	0.75	0.03	64	1.879331	10	3
34	42.5	0.54	0.005	0.5	0.75	0.03	64	1.829478	10	3
34	42.75	0.54	0.005	0.5	0.75	0.03	64	1.668495	10	3
34	43	0.54	0.005	0.5	0.75	0.03	64	1.663354	10	3
34	38	0.55	0.005	0.5	0.75	0.03	64	2.487371	10	3
34	38.25	0.55	0.005	0.5	0.75	0.03	64	2.535877	10	3
34	38.5	0.55	0.005	0.5	0.75	0.03	64	2.506953	10	3
34	38.75	0.55	0.005	0.5	0.75	0.03	64	2.499127	10	3
34	39	0.55	0.005	0.5	0.75	0.03	64	2.479138	10	3
34	39.25	0.55	0.005	0.5	0.75	0.03	64	2.497332	10	3
34	39.5	0.55	0.005	0.5	0.75	0.03	64	2.47153	10	3
34	39.75	0.55	0.005	0.5	0.75	0.03	64	2.408166	10	3
34	40	0.55	0.005	0.5	0.75	0.03	64	2.380299	10	3
34	40.25	0.55	0.005	0.5	0.75	0.03	64	2.411317	10	3
34	40.5	0.55	0.005	0.5	0.75	0.03	64	2.386556	10	3
34	40.75	0.55	0.005	0.5	0.75	0.03	64	2.322224	10	3
34	41	0.55	0.005	0.5	0.75	0.03	64	2.307629	10	3
34	41.25	0.55	0.005	0.5	0.75	0.03	64	2.092016	10	3
34	41.5	0.55	0.005	0.5	0.75	0.03	64	2.011882	10	3
34	41.75	0.55	0.005	0.5	0.75	0.03	64	1.972341	10	3
34	42	0.55	0.005	0.5	0.75	0.03	64	1.931296	10	3
34	42.25	0.55	0.005	0.5	0.75	0.03	64	1.876851	10	3
34	42.5	0.55	0.005	0.5	0.75	0.03	64	1.795386	10	3
34	42.75	0.55	0.005	0.5	0.75	0.03	64	1.666759	10	3
34	43	0.55	0.005	0.5	0.75	0.03	64	1.628133	10	3
34	38	0.56	0.005	0.5	0.75	0.03	64	2.384859	10	3
34	38.25	0.56	0.005	0.5	0.75	0.03	64	2.430965	10	3
34	38.5	0.56	0.005	0.5	0.75	0.03	64	2.438316	10	3
34	38.75	0.56	0.005	0.5	0.75	0.03	64	2.485844	10	3
34	39	0.56	0.005	0.5	0.75	0.03	64	2.472669	10	3
34	39.25	0.56	0.005	0.5	0.75	0.03	64	2.458902	10	3
34	39.5	0.56	0.005	0.5	0.75	0.03	64	2.428729	10	3
34	39.75	0.56	0.005	0.5	0.75	0.03	64	2.386446	10	3
34	40	0.56	0.005	0.5	0.75	0.03	64	2.368464	10	3
34	40.25	0.56	0.005	0.5	0.75	0.03	64	2.367006	10	3
34	40.5	0.56	0.005	0.5	0.75	0.03	64	2.345421	10	3
34	40.75	0.56	0.005	0.5	0.75	0.03	64	2.297761	10	3
34	41	0.56	0.005	0.5	0.75	0.03	64	2.267499	10	3
34	41.25	0.56	0.005	0.5	0.75	0.03	64	2.048954	10	3
34	41.5	0.56	0.005	0.5	0.75	0.03	64	1.976045	10	3
34	41.75	0.56	0.005	0.5	0.75	0.03	64	1.912248	10	3
34	42	0.56	0.005	0.5	0.75	0.03	64	1.896277	10	3
34	42.25	0.56	0.005	0.5	0.75	0.03	64	1.866763	10	3
34	42.5	0.56	0.005	0.5	0.75	0.03	64	1.77687	10	3
34	42.75	0.56	0.005	0.5	0.75	0.03	64	1.660786	10	3

Fig. 11

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR3	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	43	0.56	0.005	0.5	0.75	0.03	64	1.598593	10	3
34	38	0.57	0.005	0.5	0.75	0.03	64	2.29322	10	3
34	38.25	0.57	0.005	0.5	0.75	0.03	64	2.318528	10	3
34	38.5	0.57	0.005	0.5	0.75	0.03	64	2.371713	10	3
34	38.75	0.57	0.005	0.5	0.75	0.03	64	2.440226	10	3
34	39	0.57	0.005	0.5	0.75	0.03	64	2.439588	10	3
34	39.25	0.57	0.005	0.5	0.75	0.03	64	2.424983	10	3
34	39.5	0.57	0.005	0.5	0.75	0.03	64	2.407552	10	3
34	39.75	0.57	0.005	0.5	0.75	0.03	64	2.343643	10	3
34	40	0.57	0.005	0.5	0.75	0.03	64	2.331335	10	3
34	40.25	0.57	0.005	0.5	0.75	0.03	64	2.321218	10	3
34	40.5	0.57	0.005	0.5	0.75	0.03	64	2.313417	10	3
34	40.75	0.57	0.005	0.5	0.75	0.03	64	2.261803	10	3
34	41	0.57	0.005	0.5	0.75	0.03	64	2.240168	10	3
34	41.25	0.57	0.005	0.5	0.75	0.03	64	2.048184	10	3
34	41.5	0.57	0.005	0.5	0.75	0.03	64	1.975444	10	3
34	41.75	0.57	0.005	0.5	0.75	0.03	64	1.891455	10	3
34	42	0.57	0.005	0.5	0.75	0.03	64	1.870176	10	3
34	42.25	0.57	0.005	0.5	0.75	0.03	64	1.849415	10	3
34	42.5	0.57	0.005	0.5	0.75	0.03	64	1.758388	10	3
34	42.75	0.57	0.005	0.5	0.75	0.03	64	1.625158	10	3
34	43	0.57	0.005	0.5	0.75	0.03	64	1.562979	10	3
34	38	0.58	0.005	0.5	0.75	0.03	64	2.2449	10	3
34	38.25	0.58	0.005	0.5	0.75	0.03	64	2.200018	10	3
34	38.5	0.58	0.005	0.5	0.75	0.03	64	2.314943	10	3
34	38.75	0.58	0.005	0.5	0.75	0.03	64	2.380773	10	3
34	39	0.58	0.005	0.5	0.75	0.03	64	2.393095	10	3
34	39.25	0.58	0.005	0.5	0.75	0.03	64	2.40404	10	3
34	39.5	0.58	0.005	0.5	0.75	0.03	64	2.383528	10	3
34	39.75	0.58	0.005	0.5	0.75	0.03	64	2.325183	10	3
34	40	0.58	0.005	0.5	0.75	0.03	64	2.302531	10	3
34	40.25	0.58	0.005	0.5	0.75	0.03	64	2.2962	10	3
34	40.5	0.58	0.005	0.5	0.75	0.03	64	2.273146	10	3
34	40.75	0.58	0.005	0.5	0.75	0.03	64	2.259006	10	3
34	41	0.58	0.005	0.5	0.75	0.03	64	2.25262	10	3
34	41.25	0.58	0.005	0.5	0.75	0.03	64	2.052269	10	3
34	41.5	0.58	0.005	0.5	0.75	0.03	64	1.987241	10	3
34	41.75	0.58	0.005	0.5	0.75	0.03	64	1.888162	10	3
34	42	0.58	0.005	0.5	0.75	0.03	64	1.843398	10	3
34	42.25	0.58	0.005	0.5	0.75	0.03	64	1.83487	10	3
34	42.5	0.58	0.005	0.5	0.75	0.03	64	1.738423	10	3
34	42.75	0.58	0.005	0.5	0.75	0.03	64	1.599105	10	3
34	43	0.58	0.005	0.5	0.75	0.03	64	1.535505	10	3
34	38	0.59	0.005	0.5	0.75	0.03	64	2.184323	10	3
34	38.25	0.59	0.005	0.5	0.75	0.03	64	2.10986	10	3
34	38.5	0.59	0.005	0.5	0.75	0.03	64	2.225028	10	3
34	38.75	0.59	0.005	0.5	0.75	0.03	64	2.341652	10	3
34	39	0.59	0.005	0.5	0.75	0.03	64	2.377811	10	3
34	39.25	0.59	0.005	0.5	0.75	0.03	64	2.415963	10	3
34	39.5	0.59	0.005	0.5	0.75	0.03	64	2.350964	10	3
34	39.75	0.59	0.005	0.5	0.75	0.03	64	2.311079	10	3
34	40	0.59	0.005	0.5	0.75	0.03	64	2.303502	10	3

Fig. 11

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR3	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	40.25	0.59	0.005	0.5	0.75	0.03	64	2.305293	10	3
34	40.5	0.59	0.005	0.5	0.75	0.03	64	2.257595	10	3
34	40.75	0.59	0.005	0.5	0.75	0.03	64	2.244672	10	3
34	41	0.59	0.005	0.5	0.75	0.03	64	2.248976	10	3
34	41.25	0.59	0.005	0.5	0.75	0.03	64	2.044514	10	3
34	41.5	0.59	0.005	0.5	0.75	0.03	64	1.96695	10	3
34	41.75	0.59	0.005	0.5	0.75	0.03	64	1.897437	10	3
34	42	0.59	0.005	0.5	0.75	0.03	64	1.827485	10	3
34	42.25	0.59	0.005	0.5	0.75	0.03	64	1.807431	10	3
34	42.5	0.59	0.005	0.5	0.75	0.03	64	1.701863	10	3
34	42.75	0.59	0.005	0.5	0.75	0.03	64	1.565639	10	3
34	43	0.59	0.005	0.5	0.75	0.03	64	1.505227	10	3
34	38	0.6	0.005	0.5	0.75	0.03	64	2.116379	10	3
34	38.25	0.6	0.005	0.5	0.75	0.03	64	2.034801	10	3
34	38.5	0.6	0.005	0.5	0.75	0.03	64	2.163161	10	3
34	38.75	0.6	0.005	0.5	0.75	0.03	64	2.317819	10	3
34	39	0.6	0.005	0.5	0.75	0.03	64	2.379017	10	3
34	39.25	0.6	0.005	0.5	0.75	0.03	64	2.441714	10	3
34	39.5	0.6	0.005	0.5	0.75	0.03	64	2.360155	10	3
34	39.75	0.6	0.005	0.5	0.75	0.03	64	2.303409	10	3
34	40	0.6	0.005	0.5	0.75	0.03	64	2.302245	10	3
34	40.25	0.6	0.005	0.5	0.75	0.03	64	2.32489	10	3
34	40.5	0.6	0.005	0.5	0.75	0.03	64	2.245972	10	3
34	40.75	0.6	0.005	0.5	0.75	0.03	64	2.227678	10	3
34	41	0.6	0.005	0.5	0.75	0.03	64	2.252926	10	3
34	41.25	0.6	0.005	0.5	0.75	0.03	64	2.052099	10	3
34	41.5	0.6	0.005	0.5	0.75	0.03	64	1.97704	10	3
34	41.75	0.6	0.005	0.5	0.75	0.03	64	1.896367	10	3
34	42	0.6	0.005	0.5	0.75	0.03	64	1.821832	10	3
34	42.25	0.6	0.005	0.5	0.75	0.03	64	1.786714	10	3
34	42.5	0.6	0.005	0.5	0.75	0.03	64	1.685721	10	3
34	42.75	0.6	0.005	0.5	0.75	0.03	64	1.530645	10	3
34	43	0.6	0.005	0.5	0.75	0.03	64	1.464473	10	3
34	38	0.61	0.005	0.5	0.75	0.03	64	2.080339	10	3
34	38.25	0.61	0.005	0.5	0.75	0.03	64	2.029245	10	3
34	38.5	0.61	0.005	0.5	0.75	0.03	64	2.130434	10	3
34	38.75	0.61	0.005	0.5	0.75	0.03	64	2.287073	10	3
34	39	0.61	0.005	0.5	0.75	0.03	64	2.360598	10	3
34	39.25	0.61	0.005	0.5	0.75	0.03	64	2.475646	10	3
34	39.5	0.61	0.005	0.5	0.75	0.03	64	2.363741	10	3
34	39.75	0.61	0.005	0.5	0.75	0.03	64	2.296805	10	3
34	40	0.61	0.005	0.5	0.75	0.03	64	2.300797	10	3
34	40.25	0.61	0.005	0.5	0.75	0.03	64	2.317179	10	3
34	40.5	0.61	0.005	0.5	0.75	0.03	64	2.254045	10	3
34	40.75	0.61	0.005	0.5	0.75	0.03	64	2.213688	10	3
34	41	0.61	0.005	0.5	0.75	0.03	64	2.243129	10	3
34	41.25	0.61	0.005	0.5	0.75	0.03	64	2.031185	10	3
34	41.5	0.61	0.005	0.5	0.75	0.03	64	1.965116	10	3
34	41.75	0.61	0.005	0.5	0.75	0.03	64	1.879425	10	3
34	42	0.61	0.005	0.5	0.75	0.03	64	1.809611	10	3
34	42.25	0.61	0.005	0.5	0.75	0.03	64	1.769346	10	3
34	42.5	0.61	0.005	0.5	0.75	0.03	64	1.679952	10	3

Fig. 11

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR3	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	42.75	0.61	0.005	0.5	0.75	0.03	64	1.484666	10	3
34	43	0.61	0.005	0.5	0.75	0.03	64	1.43055	10	3
34	38	0.62	0.005	0.5	0.75	0.03	64	2.030581	10	3
34	38.25	0.62	0.005	0.5	0.75	0.03	64	2.034123	10	3
34	38.5	0.62	0.005	0.5	0.75	0.03	64	2.090965	10	3
34	38.75	0.62	0.005	0.5	0.75	0.03	64	2.255456	10	3
34	39	0.62	0.005	0.5	0.75	0.03	64	2.349043	10	3
34	39.25	0.62	0.005	0.5	0.75	0.03	64	2.47217	10	3
34	39.5	0.62	0.005	0.5	0.75	0.03	64	2.355233	10	3
34	39.75	0.62	0.005	0.5	0.75	0.03	64	2.295602	10	3
34	40	0.62	0.005	0.5	0.75	0.03	64	2.304955	10	3
34	40.25	0.62	0.005	0.5	0.75	0.03	64	2.30649	10	3
34	40.5	0.62	0.005	0.5	0.75	0.03	64	2.248172	10	3
34	40.75	0.62	0.005	0.5	0.75	0.03	64	2.199159	10	3
34	41	0.62	0.005	0.5	0.75	0.03	64	2.22692	10	3
34	41.25	0.62	0.005	0.5	0.75	0.03	64	2.005718	10	3
34	41.5	0.62	0.005	0.5	0.75	0.03	64	1.951076	10	3
34	41.75	0.62	0.005	0.5	0.75	0.03	64	1.868956	10	3
34	42	0.62	0.005	0.5	0.75	0.03	64	1.772161	10	3
34	42.25	0.62	0.005	0.5	0.75	0.03	64	1.734037	10	3
34	42.5	0.62	0.005	0.5	0.75	0.03	64	1.655716	10	3
34	42.75	0.62	0.005	0.5	0.75	0.03	64	1.475449	10	3
34	43	0.62	0.005	0.5	0.75	0.03	64	1.401287	10	3
34	38	0.63	0.005	0.5	0.75	0.03	64	1.994225	10	3
34	38.25	0.63	0.005	0.5	0.75	0.03	64	2.015877	10	3
34	38.5	0.63	0.005	0.5	0.75	0.03	64	2.045052	10	3
34	38.75	0.63	0.005	0.5	0.75	0.03	64	2.221786	10	3
34	39	0.63	0.005	0.5	0.75	0.03	64	2.346742	10	3
34	39.25	0.63	0.005	0.5	0.75	0.03	64	2.490031	10	3
34	39.5	0.63	0.005	0.5	0.75	0.03	64	2.376295	10	3
34	39.75	0.63	0.005	0.5	0.75	0.03	64	2.28009	10	3
34	40	0.63	0.005	0.5	0.75	0.03	64	2.297561	10	3
34	40.25	0.63	0.005	0.5	0.75	0.03	64	2.276601	10	3
34	40.5	0.63	0.005	0.5	0.75	0.03	64	2.248214	10	3
34	40.75	0.63	0.005	0.5	0.75	0.03	64	2.217128	10	3
34	41	0.63	0.005	0.5	0.75	0.03	64	2.208079	10	3
34	41.25	0.63	0.005	0.5	0.75	0.03	64	1.970603	10	3
34	41.5	0.63	0.005	0.5	0.75	0.03	64	1.92719	10	3
34	41.75	0.63	0.005	0.5	0.75	0.03	64	1.846185	10	3
34	42	0.63	0.005	0.5	0.75	0.03	64	1.745782	10	3
34	42.25	0.63	0.005	0.5	0.75	0.03	64	1.680691	10	3
34	42.5	0.63	0.005	0.5	0.75	0.03	64	1.627786	10	3
34	42.75	0.63	0.005	0.5	0.75	0.03	64	1.449062	10	3
34	43	0.63	0.005	0.5	0.75	0.03	64	1.378223	10	3
34	38	0.64	0.005	0.5	0.75	0.03	64	1.937163	10	3
34	38.25	0.64	0.005	0.5	0.75	0.03	64	1.986276	10	3
34	38.5	0.64	0.005	0.5	0.75	0.03	64	2.104674	10	3
34	38.75	0.64	0.005	0.5	0.75	0.03	64	2.177021	10	3
34	39	0.64	0.005	0.5	0.75	0.03	64	2.339914	10	3
34	39.25	0.64	0.005	0.5	0.75	0.03	64	2.485933	10	3
34	39.5	0.64	0.005	0.5	0.75	0.03	64	2.371974	10	3
34	39.75	0.64	0.005	0.5	0.75	0.03	64	2.260436	10	3

Fig. 11

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR3	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	40	0.64	0.005	0.5	0.75	0.03	64	2.288242	10	3
34	40.25	0.64	0.005	0.5	0.75	0.03	64	2.259336	10	3
34	40.5	0.64	0.005	0.5	0.75	0.03	64	2.230171	10	3
34	40.75	0.64	0.005	0.5	0.75	0.03	64	2.196695	10	3
34	41	0.64	0.005	0.5	0.75	0.03	64	2.200361	10	3
34	41.25	0.64	0.005	0.5	0.75	0.03	64	1.928936	10	3
34	41.5	0.64	0.005	0.5	0.75	0.03	64	1.887913	10	3
34	41.75	0.64	0.005	0.5	0.75	0.03	64	1.829684	10	3
34	42	0.64	0.005	0.5	0.75	0.03	64	1.694517	10	3
34	42.25	0.64	0.005	0.5	0.75	0.03	64	1.641441	10	3
34	42.5	0.64	0.005	0.5	0.75	0.03	64	1.593743	10	3
34	42.75	0.64	0.005	0.5	0.75	0.03	64	1.399281	10	3
34	43	0.64	0.005	0.5	0.75	0.03	64	1.381328	10	3
34	38	0.65	0.005	0.5	0.75	0.03	64	1.875263	10	3
34	38.25	0.65	0.005	0.5	0.75	0.03	64	1.950259	10	3
34	38.5	0.65	0.005	0.5	0.75	0.03	64	2.111066	10	3
34	38.75	0.65	0.005	0.5	0.75	0.03	64	2.122745	10	3
34	39	0.65	0.005	0.5	0.75	0.03	64	2.318192	10	3
34	39.25	0.65	0.005	0.5	0.75	0.03	64	2.471633	10	3
34	39.5	0.65	0.005	0.5	0.75	0.03	64	2.353229	10	3
34	39.75	0.65	0.005	0.5	0.75	0.03	64	2.272917	10	3
34	40	0.65	0.005	0.5	0.75	0.03	64	2.274338	10	3
34	40.25	0.65	0.005	0.5	0.75	0.03	64	2.239931	10	3
34	40.5	0.65	0.005	0.5	0.75	0.03	64	2.193809	10	3
34	40.75	0.65	0.005	0.5	0.75	0.03	64	2.195184	10	3
34	41	0.65	0.005	0.5	0.75	0.03	64	2.202781	10	3
34	41.25	0.65	0.005	0.5	0.75	0.03	64	1.906847	10	3
34	41.5	0.65	0.005	0.5	0.75	0.03	64	1.837126	10	3
34	41.75	0.65	0.005	0.5	0.75	0.03	64	1.776166	10	3
34	42	0.65	0.005	0.5	0.75	0.03	64	1.634451	10	3
34	42.25	0.65	0.005	0.5	0.75	0.03	64	1.59568	10	3
34	42.5	0.65	0.005	0.5	0.75	0.03	64	1.544586	10	3
34	42.75	0.65	0.005	0.5	0.75	0.03	64	1.350085	10	3
34	43	0.65	0.005	0.5	0.75	0.03	64	1.359024	10	3

Fig. 12

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR2	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	0.52	0.005	0.005	0.5	0.75	0.03	64	0.830853	10	2
34	0.52	0.005	0.005	0.5	0.75	0.03	64	0.815603	10	2
34	38.5	0.52	0.005	0.5	0.75	0.03	64	0.775263	10	2
34	38.75	0.52	0.005	0.5	0.75	0.03	64	0.782148	10	2
34	39	0.52	0.005	0.5	0.75	0.03	64	0.842428	10	2
34	39.25	0.52	0.005	0.5	0.75	0.03	64	0.886842	10	2
34	39.5	0.52	0.005	0.5	0.75	0.03	64	0.887367	10	2
34	39.75	0.52	0.005	0.5	0.75	0.03	64	0.897572	10	2
34	40	0.52	0.005	0.5	0.75	0.03	64	0.912094	10	2
34	40.25	0.52	0.005	0.5	0.75	0.03	64	0.903303	10	2
34	40.5	0.52	0.005	0.5	0.75	0.03	64	0.884455	10	2
34	40.75	0.52	0.005	0.5	0.75	0.03	64	0.859532	10	2
34	41	0.52	0.005	0.5	0.75	0.03	64	0.835571	10	2
34	41.25	0.52	0.005	0.5	0.75	0.03	64	0.792055	10	2
34	41.5	0.52	0.005	0.5	0.75	0.03	64	0.794804	10	2
34	41.75	0.52	0.005	0.5	0.75	0.03	64	0.777571	10	2
34	42	0.52	0.005	0.5	0.75	0.03	64	0.755794	10	2
34	42.25	0.52	0.005	0.5	0.75	0.03	64	0.741343	10	2
34	42.5	0.52	0.005	0.5	0.75	0.03	64	0.679849	10	2
34	42.75	0.52	0.005	0.5	0.75	0.03	64	0.632107	10	2
34	43	0.52	0.005	0.5	0.75	0.03	64	0.621586	10	2
34	38	0.53	0.005	0.5	0.75	0.03	64	0.825816	10	2
34	38.25	0.53	0.005	0.5	0.75	0.03	64	0.81762	10	2
34	38.5	0.53	0.005	0.5	0.75	0.03	64	0.775303	10	2
34	38.75	0.53	0.005	0.5	0.75	0.03	64	0.781034	10	2
34	39	0.53	0.005	0.5	0.75	0.03	64	0.839315	10	2
34	39.25	0.53	0.005	0.5	0.75	0.03	64	0.883481	10	2
34	39.5	0.53	0.005	0.5	0.75	0.03	64	0.883092	10	2
34	39.75	0.53	0.005	0.5	0.75	0.03	64	0.898849	10	2
34	40	0.53	0.005	0.5	0.75	0.03	64	0.914231	10	2
34	40.25	0.53	0.005	0.5	0.75	0.03	64	0.905167	10	2
34	40.5	0.53	0.005	0.5	0.75	0.03	64	0.876516	10	2
34	40.75	0.53	0.005	0.5	0.75	0.03	64	0.849069	10	2
34	41	0.53	0.005	0.5	0.75	0.03	64	0.81637	10	2
34	41.25	0.53	0.005	0.5	0.75	0.03	64	0.767044	10	2
34	41.5	0.53	0.005	0.5	0.75	0.03	64	0.760056	10	2
34	41.75	0.53	0.005	0.5	0.75	0.03	64	0.753359	10	2
34	42	0.53	0.005	0.5	0.75	0.03	64	0.74058	10	2
34	42.25	0.53	0.005	0.5	0.75	0.03	64	0.723465	10	2
34	42.5	0.53	0.005	0.5	0.75	0.03	64	0.661301	10	2
34	42.75	0.53	0.005	0.5	0.75	0.03	64	0.612867	10	2
34	43	0.53	0.005	0.5	0.75	0.03	64	0.598343	10	2
34	38	0.54	0.005	0.5	0.75	0.03	64	0.820859	10	2
34	38.25	0.54	0.005	0.5	0.75	0.03	64	0.812162	10	2
34	38.5	0.54	0.005	0.5	0.75	0.03	64	0.773306	10	2
34	38.75	0.54	0.005	0.5	0.75	0.03	64	0.778817	10	2
34	39	0.54	0.005	0.5	0.75	0.03	64	0.828487	10	2
34	39.25	0.54	0.005	0.5	0.75	0.03	64	0.872852	10	2
34	39.5	0.54	0.005	0.5	0.75	0.03	64	0.878725	10	2
34	39.75	0.54	0.005	0.5	0.75	0.03	64	0.905091	10	2
34	40	0.54	0.005	0.5	0.75	0.03	64	0.917503	10	2
34	40.25	0.54	0.005	0.5	0.75	0.03	64	0.906994	10	2

Fig. 12

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR2	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	40.5	0.54	0.005	0.5	0.75	0.03	64	0.869909	10	2
34	40.75	0.54	0.005	0.5	0.75	0.03	64	0.840489	10	2
34	41	0.54	0.005	0.5	0.75	0.03	64	0.804084	10	2
34	41.25	0.54	0.005	0.5	0.75	0.03	64	0.747225	10	2
34	41.5	0.54	0.005	0.5	0.75	0.03	64	0.728934	10	2
34	41.75	0.54	0.005	0.5	0.75	0.03	64	0.721268	10	2
34	42	0.54	0.005	0.5	0.75	0.03	64	0.723959	10	2
34	42.25	0.54	0.005	0.5	0.75	0.03	64	0.712998	10	2
34	42.5	0.54	0.005	0.5	0.75	0.03	64	0.648709	10	2
34	42.75	0.54	0.005	0.5	0.75	0.03	64	0.596706	10	2
34	43	0.54	0.005	0.5	0.75	0.03	64	0.577741	10	2
34	38	0.55	0.005	0.5	0.75	0.03	64	0.814714	10	2
34	38.25	0.55	0.005	0.5	0.75	0.03	64	0.801091	10	2
34	38.5	0.55	0.005	0.5	0.75	0.03	64	0.771957	10	2
34	38.75	0.55	0.005	0.5	0.75	0.03	64	0.771773	10	2
34	39	0.55	0.005	0.5	0.75	0.03	64	0.816006	10	2
34	39.25	0.55	0.005	0.5	0.75	0.03	64	0.860403	10	2
34	39.5	0.55	0.005	0.5	0.75	0.03	64	0.874857	10	2
34	39.75	0.55	0.005	0.5	0.75	0.03	64	0.904774	10	2
34	40	0.55	0.005	0.5	0.75	0.03	64	0.917906	10	2
34	40.25	0.55	0.005	0.5	0.75	0.03	64	0.902202	10	2
34	40.5	0.55	0.005	0.5	0.75	0.03	64	0.865573	10	2
34	40.75	0.55	0.005	0.5	0.75	0.03	64	0.836369	10	2
34	41	0.55	0.005	0.5	0.75	0.03	64	0.797574	10	2
34	41.25	0.55	0.005	0.5	0.75	0.03	64	0.733143	10	2
34	41.5	0.55	0.005	0.5	0.75	0.03	64	0.716023	10	2
34	41.75	0.55	0.005	0.5	0.75	0.03	64	0.704124	10	2
34	42	0.55	0.005	0.5	0.75	0.03	64	0.70276	10	2
34	42.25	0.55	0.005	0.5	0.75	0.03	64	0.698674	10	2
34	42.5	0.55	0.005	0.5	0.75	0.03	64	0.64128	10	2
34	42.75	0.55	0.005	0.5	0.75	0.03	64	0.585837	10	2
34	43	0.55	0.005	0.5	0.75	0.03	64	0.562732	10	2
34	38	0.56	0.005	0.5	0.75	0.03	64	0.810342	10	2
34	38.25	0.56	0.005	0.5	0.75	0.03	64	0.79447	10	2
34	38.5	0.56	0.005	0.5	0.75	0.03	64	0.76528	10	2
34	38.75	0.56	0.005	0.5	0.75	0.03	64	0.765746	10	2
34	39	0.56	0.005	0.5	0.75	0.03	64	0.810468	10	2
34	39.25	0.56	0.005	0.5	0.75	0.03	64	0.851028	10	2
34	39.5	0.56	0.005	0.5	0.75	0.03	64	0.868444	10	2
34	39.75	0.56	0.005	0.5	0.75	0.03	64	0.901324	10	2
34	40	0.56	0.005	0.5	0.75	0.03	64	0.908834	10	2
34	40.25	0.56	0.005	0.5	0.75	0.03	64	0.897934	10	2
34	40.5	0.56	0.005	0.5	0.75	0.03	64	0.863241	10	2
34	40.75	0.56	0.005	0.5	0.75	0.03	64	0.831788	10	2
34	41	0.56	0.005	0.5	0.75	0.03	64	0.794494	10	2
34	41.25	0.56	0.005	0.5	0.75	0.03	64	0.729545	10	2
34	41.5	0.56	0.005	0.5	0.75	0.03	64	0.714573	10	2
34	41.75	0.56	0.005	0.5	0.75	0.03	64	0.700948	10	2
34	42	0.56	0.005	0.5	0.75	0.03	64	0.688704	10	2
34	42.25	0.56	0.005	0.5	0.75	0.03	64	0.6823	10	2
34	42.5	0.56	0.005	0.5	0.75	0.03	64	0.630612	10	2
34	42.75	0.56	0.005	0.5	0.75	0.03	64	0.584443	10	2

Fig. 12										
Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR2	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	43	0.56	0.005	0.5	0.75	0.03	64	0.554585	10	2
34	38	0.57	0.005	0.5	0.75	0.03	64	0.799847	10	2
34	38.25	0.57	0.005	0.5	0.75	0.03	64	0.785196	10	2
34	38.5	0.57	0.005	0.5	0.75	0.03	64	0.757498	10	2
34	38.75	0.57	0.005	0.5	0.75	0.03	64	0.767361	10	2
34	39	0.57	0.005	0.5	0.75	0.03	64	0.813698	10	2
34	39.25	0.57	0.005	0.5	0.75	0.03	64	0.847284	10	2
34	39.5	0.57	0.005	0.5	0.75	0.03	64	0.859142	10	2
34	39.75	0.57	0.005	0.5	0.75	0.03	64	0.893763	10	2
34	40	0.57	0.005	0.5	0.75	0.03	64	0.902374	10	2
34	40.25	0.57	0.005	0.5	0.75	0.03	64	0.892721	10	2
34	40.5	0.57	0.005	0.5	0.75	0.03	64	0.863287	10	2
34	40.75	0.57	0.005	0.5	0.75	0.03	64	0.835853	10	2
34	41	0.57	0.005	0.5	0.75	0.03	64	0.798168	10	2
34	41.25	0.57	0.005	0.5	0.75	0.03	64	0.727064	10	2
34	41.5	0.57	0.005	0.5	0.75	0.03	64	0.711888	10	2
34	41.75	0.57	0.005	0.5	0.75	0.03	64	0.698537	10	2
34	42	0.57	0.005	0.5	0.75	0.03	64	0.68543	10	2
34	42.25	0.57	0.005	0.5	0.75	0.03	64	0.667086	10	2
34	42.5	0.57	0.005	0.5	0.75	0.03	64	0.614259	10	2
34	42.75	0.57	0.005	0.5	0.75	0.03	64	0.578013	10	2
34	43	0.57	0.005	0.5	0.75	0.03	64	0.55583	10	2
34	38	0.58	0.005	0.5	0.75	0.03	64	0.77155	10	2
34	38.25	0.58	0.005	0.5	0.75	0.03	64	0.770125	10	2
34	38.5	0.58	0.005	0.5	0.75	0.03	64	0.750826	10	2
34	38.75	0.58	0.005	0.5	0.75	0.03	64	0.776609	10	2
34	39	0.58	0.005	0.5	0.75	0.03	64	0.822064	10	2
34	39.25	0.58	0.005	0.5	0.75	0.03	64	0.845895	10	2
34	39.5	0.58	0.005	0.5	0.75	0.03	64	0.845349	10	2
34	39.75	0.58	0.005	0.5	0.75	0.03	64	0.880472	10	2
34	40	0.58	0.005	0.5	0.75	0.03	64	0.898266	10	2
34	40.25	0.58	0.005	0.5	0.75	0.03	64	0.895248	10	2
34	40.5	0.58	0.005	0.5	0.75	0.03	64	0.871497	10	2
34	40.75	0.58	0.005	0.5	0.75	0.03	64	0.841391	10	2
34	41	0.58	0.005	0.5	0.75	0.03	64	0.798846	10	2
34	41.25	0.58	0.005	0.5	0.75	0.03	64	0.724288	10	2
34	41.5	0.58	0.005	0.5	0.75	0.03	64	0.708505	10	2
34	41.75	0.58	0.005	0.5	0.75	0.03	64	0.69511	10	2
34	42	0.58	0.005	0.5	0.75	0.03	64	0.683728	10	2
34	42.25	0.58	0.005	0.5	0.75	0.03	64	0.648917	10	2
34	42.5	0.58	0.005	0.5	0.75	0.03	64	0.603922	10	2
34	42.75	0.58	0.005	0.5	0.75	0.03	64	0.566235	10	2
34	43	0.58	0.005	0.5	0.75	0.03	64	0.549192	10	2
34	38	0.59	0.005	0.5	0.75	0.03	64	0.739426	10	2
34	38.25	0.59	0.005	0.5	0.75	0.03	64	0.74518	10	2
34	38.5	0.59	0.005	0.5	0.75	0.03	64	0.754325	10	2
34	38.75	0.59	0.005	0.5	0.75	0.03	64	0.787261	10	2
34	39	0.59	0.005	0.5	0.75	0.03	64	0.831711	10	2
34	39.25	0.59	0.005	0.5	0.75	0.03	64	0.845679	10	2
34	39.5	0.59	0.005	0.5	0.75	0.03	64	0.832287	10	2
34	39.75	0.59	0.005	0.5	0.75	0.03	64	0.875182	10	2
34	40	0.59	0.005	0.5	0.75	0.03	64	0.901357	10	2

Fig. 12

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR2	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	40.25	0.59	0.005	0.5	0.75	0.03	64	0.898708	10	2
34	40.5	0.59	0.005	0.5	0.75	0.03	64	0.876342	10	2
34	40.75	0.59	0.005	0.5	0.75	0.03	64	0.846584	10	2
34	41	0.59	0.005	0.5	0.75	0.03	64	0.799008	10	2
34	41.25	0.59	0.005	0.5	0.75	0.03	64	0.720892	10	2
34	41.5	0.59	0.005	0.5	0.75	0.03	64	0.704366	10	2
34	41.75	0.59	0.005	0.5	0.75	0.03	64	0.690144	10	2
34	42	0.59	0.005	0.5	0.75	0.03	64	0.678995	10	2
34	42.25	0.59	0.005	0.5	0.75	0.03	64	0.644305	10	2
34	42.5	0.59	0.005	0.5	0.75	0.03	64	0.601934	10	2
34	42.75	0.59	0.005	0.5	0.75	0.03	64	0.559082	10	2
34	43	0.59	0.005	0.5	0.75	0.03	64	0.538236	10	2
34	38	0.6	0.005	0.5	0.75	0.03	64	0.715373	10	2
34	38.25	0.6	0.005	0.5	0.75	0.03	64	0.72763	10	2
34	38.5	0.6	0.005	0.5	0.75	0.03	64	0.7517	10	2
34	38.75	0.6	0.005	0.5	0.75	0.03	64	0.796534	10	2
34	39	0.6	0.005	0.5	0.75	0.03	64	0.839021	10	2
34	39.25	0.6	0.005	0.5	0.75	0.03	64	0.844216	10	2
34	39.5	0.6	0.005	0.5	0.75	0.03	64	0.829233	10	2
34	39.75	0.6	0.005	0.5	0.75	0.03	64	0.870356	10	2
34	40	0.6	0.005	0.5	0.75	0.03	64	0.900867	10	2
34	40.25	0.6	0.005	0.5	0.75	0.03	64	0.900702	10	2
34	40.5	0.6	0.005	0.5	0.75	0.03	64	0.877821	10	2
34	40.75	0.6	0.005	0.5	0.75	0.03	64	0.850258	10	2
34	41	0.6	0.005	0.5	0.75	0.03	64	0.79833	10	2
34	41.25	0.6	0.005	0.5	0.75	0.03	64	0.7168	10	2
34	41.5	0.6	0.005	0.5	0.75	0.03	64	0.699282	10	2
34	41.75	0.6	0.005	0.5	0.75	0.03	64	0.684268	10	2
34	42	0.6	0.005	0.5	0.75	0.03	64	0.675258	10	2
34	42.25	0.6	0.005	0.5	0.75	0.03	64	0.642043	10	2
34	42.5	0.6	0.005	0.5	0.75	0.03	64	0.602407	10	2
34	42.75	0.6	0.005	0.5	0.75	0.03	64	0.55821	10	2
34	43	0.6	0.005	0.5	0.75	0.03	64	0.529726	10	2
34	38	0.61	0.005	0.5	0.75	0.03	64	0.707912	10	2
34	38.25	0.61	0.005	0.5	0.75	0.03	64	0.713188	10	2
34	38.5	0.61	0.005	0.5	0.75	0.03	64	0.747195	10	2
34	38.75	0.61	0.005	0.5	0.75	0.03	64	0.802606	10	2
34	39	0.61	0.005	0.5	0.75	0.03	64	0.846035	10	2
34	39.25	0.61	0.005	0.5	0.75	0.03	64	0.840474	10	2
34	39.5	0.61	0.005	0.5	0.75	0.03	64	0.826305	10	2
34	39.75	0.61	0.005	0.5	0.75	0.03	64	0.865902	10	2
34	40	0.61	0.005	0.5	0.75	0.03	64	0.897907	10	2
34	40.25	0.61	0.005	0.5	0.75	0.03	64	0.90003	10	2
34	40.5	0.61	0.005	0.5	0.75	0.03	64	0.875527	10	2
34	40.75	0.61	0.005	0.5	0.75	0.03	64	0.852055	10	2
34	41	0.61	0.005	0.5	0.75	0.03	64	0.796219	10	2
34	41.25	0.61	0.005	0.5	0.75	0.03	64	0.711018	10	2
34	41.5	0.61	0.005	0.5	0.75	0.03	64	0.692775	10	2
34	41.75	0.61	0.005	0.5	0.75	0.03	64	0.678103	10	2
34	42	0.61	0.005	0.5	0.75	0.03	64	0.669315	10	2
34	42.25	0.61	0.005	0.5	0.75	0.03	64	0.639022	10	2
34	42.5	0.61	0.005	0.5	0.75	0.03	64	0.602829	10	2

Fig. 12

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR2	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	42.75	0.61	0.005	0.5	0.75	0.03	64	0.557297	10	2
34	43	0.61	0.005	0.5	0.75	0.03	64	0.524737	10	2
34	38	0.62	0.005	0.5	0.75	0.03	64	0.706711	10	2
34	38.25	0.62	0.005	0.5	0.75	0.03	64	0.702224	10	2
34	38.5	0.62	0.005	0.5	0.75	0.03	64	0.743246	10	2
34	38.75	0.62	0.005	0.5	0.75	0.03	64	0.80033	10	2
34	39	0.62	0.005	0.5	0.75	0.03	64	0.853166	10	2
34	39.25	0.62	0.005	0.5	0.75	0.03	64	0.837159	10	2
34	39.5	0.62	0.005	0.5	0.75	0.03	64	0.828514	10	2
34	39.75	0.62	0.005	0.5	0.75	0.03	64	0.863602	10	2
34	40	0.62	0.005	0.5	0.75	0.03	64	0.891697	10	2
34	40.25	0.62	0.005	0.5	0.75	0.03	64	0.896706	10	2
34	40.5	0.62	0.005	0.5	0.75	0.03	64	0.872329	10	2
34	40.75	0.62	0.005	0.5	0.75	0.03	64	0.851519	10	2
34	41	0.62	0.005	0.5	0.75	0.03	64	0.79316	10	2
34	41.25	0.62	0.005	0.5	0.75	0.03	64	0.703072	10	2
34	41.5	0.62	0.005	0.5	0.75	0.03	64	0.685047	10	2
34	41.75	0.62	0.005	0.5	0.75	0.03	64	0.671654	10	2
34	42	0.62	0.005	0.5	0.75	0.03	64	0.663322	10	2
34	42.25	0.62	0.005	0.5	0.75	0.03	64	0.633063	10	2
34	42.5	0.62	0.005	0.5	0.75	0.03	64	0.601153	10	2
34	42.75	0.62	0.005	0.5	0.75	0.03	64	0.554241	10	2
34	43	0.62	0.005	0.5	0.75	0.03	64	0.520811	10	2
34	38	0.63	0.005	0.5	0.75	0.03	64	0.707739	10	2
34	38.25	0.63	0.005	0.5	0.75	0.03	64	0.710567	10	2
34	38.5	0.63	0.005	0.5	0.75	0.03	64	0.737919	10	2
34	38.75	0.63	0.005	0.5	0.75	0.03	64	0.796747	10	2
34	39	0.63	0.005	0.5	0.75	0.03	64	0.848361	10	2
34	39.25	0.63	0.005	0.5	0.75	0.03	64	0.836786	10	2
34	39.5	0.63	0.005	0.5	0.75	0.03	64	0.825664	10	2
34	39.75	0.63	0.005	0.5	0.75	0.03	64	0.860696	10	2
34	40	0.63	0.005	0.5	0.75	0.03	64	0.884747	10	2
34	40.25	0.63	0.005	0.5	0.75	0.03	64	0.889581	10	2
34	40.5	0.63	0.005	0.5	0.75	0.03	64	0.868553	10	2
34	40.75	0.63	0.005	0.5	0.75	0.03	64	0.847611	10	2
34	41	0.63	0.005	0.5	0.75	0.03	64	0.789609	10	2
34	41.25	0.63	0.005	0.5	0.75	0.03	64	0.693305	10	2
34	41.5	0.63	0.005	0.5	0.75	0.03	64	0.677208	10	2
34	41.75	0.63	0.005	0.5	0.75	0.03	64	0.664778	10	2
34	42	0.63	0.005	0.5	0.75	0.03	64	0.657323	10	2
34	42.25	0.63	0.005	0.5	0.75	0.03	64	0.623253	10	2
34	42.5	0.63	0.005	0.5	0.75	0.03	64	0.593124	10	2
34	42.75	0.63	0.005	0.5	0.75	0.03	64	0.551869	10	2
34	43	0.63	0.005	0.5	0.75	0.03	64	0.516824	10	2
34	38	0.64	0.005	0.5	0.75	0.03	64	0.710207	10	2
34	38.25	0.64	0.005	0.5	0.75	0.03	64	0.723086	10	2
34	38.5	0.64	0.005	0.5	0.75	0.03	64	0.732374	10	2
34	38.75	0.64	0.005	0.5	0.75	0.03	64	0.791999	10	2
34	39	0.64	0.005	0.5	0.75	0.03	64	0.840977	10	2
34	39.25	0.64	0.005	0.5	0.75	0.03	64	0.822409	10	2
34	39.5	0.64	0.005	0.5	0.75	0.03	64	0.828563	10	2
34	39.75	0.64	0.005	0.5	0.75	0.03	64	0.856142	10	2

Fig. 12

Crown Angle	Pavillion Angle	Table Size	Culet Size	Star Length	Lower Girdle Length	Girdle Thickness	# of Girdle Facets	DCLR2	Wavelength Sampling Interval (nm)	Brightness Cutoff Threshold Factor
34	40	0.64	0.005	0.5	0.75	0.03	64	0.879889	10	2
34	40.25	0.64	0.005	0.5	0.75	0.03	64	0.879822	10	2
34	40.5	0.64	0.005	0.5	0.75	0.03	64	0.863085	10	2
34	40.75	0.64	0.005	0.5	0.75	0.03	64	0.840276	10	2
34	41	0.64	0.005	0.5	0.75	0.03	64	0.784399	10	2
34	41.25	0.64	0.005	0.5	0.75	0.03	64	0.683366	10	2
34	41.5	0.64	0.005	0.5	0.75	0.03	64	0.669707	10	2
34	41.75	0.64	0.005	0.5	0.75	0.03	64	0.65738	10	2
34	42	0.64	0.005	0.5	0.75	0.03	64	0.646081	10	2
34	42.25	0.64	0.005	0.5	0.75	0.03	64	0.613999	10	2
34	42.5	0.64	0.005	0.5	0.75	0.03	64	0.581597	10	2
34	42.75	0.64	0.005	0.5	0.75	0.03	64	0.545589	10	2
34	43	0.64	0.005	0.5	0.75	0.03	64	0.510111	10	2
34	38	0.65	0.005	0.5	0.75	0.03	64	0.715558	10	2
34	38.25	0.65	0.005	0.5	0.75	0.03	64	0.736196	10	2
34	38.5	0.65	0.005	0.5	0.75	0.03	64	0.745934	10	2
34	38.75	0.65	0.005	0.5	0.75	0.03	64	0.785599	10	2
34	39	0.65	0.005	0.5	0.75	0.03	64	0.833372	10	2
34	39.25	0.65	0.005	0.5	0.75	0.03	64	0.802325	10	2
34	39.5	0.65	0.005	0.5	0.75	0.03	64	0.822724	10	2
34	39.75	0.65	0.005	0.5	0.75	0.03	64	0.85561	10	2
34	40	0.65	0.005	0.5	0.75	0.03	64	0.874749	10	2
34	40.25	0.65	0.005	0.5	0.75	0.03	64	0.871053	10	2
34	40.5	0.65	0.005	0.5	0.75	0.03	64	0.856115	10	2
34	40.75	0.65	0.005	0.5	0.75	0.03	64	0.831199	10	2
34	41	0.65	0.005	0.5	0.75	0.03	64	0.775398	10	2
34	41.25	0.65	0.005	0.5	0.75	0.03	64	0.674185	10	2
34	41.5	0.65	0.005	0.5	0.75	0.03	64	0.66234	10	2
34	41.75	0.65	0.005	0.5	0.75	0.03	64	0.649616	10	2
34	42	0.65	0.005	0.5	0.75	0.03	64	0.625126	10	2
34	42.25	0.65	0.005	0.5	0.75	0.03	64	0.606534	10	2
34	42.5	0.65	0.005	0.5	0.75	0.03	64	0.573906	10	2
34	42.75	0.65	0.005	0.5	0.75	0.03	64	0.538178	10	2
34	43	0.65	0.005	0.5	0.75	0.03	64	0.510028	10	2

Fig 13

Fig 14

Fig 15

Fig 16

Fig 17

Fig 18

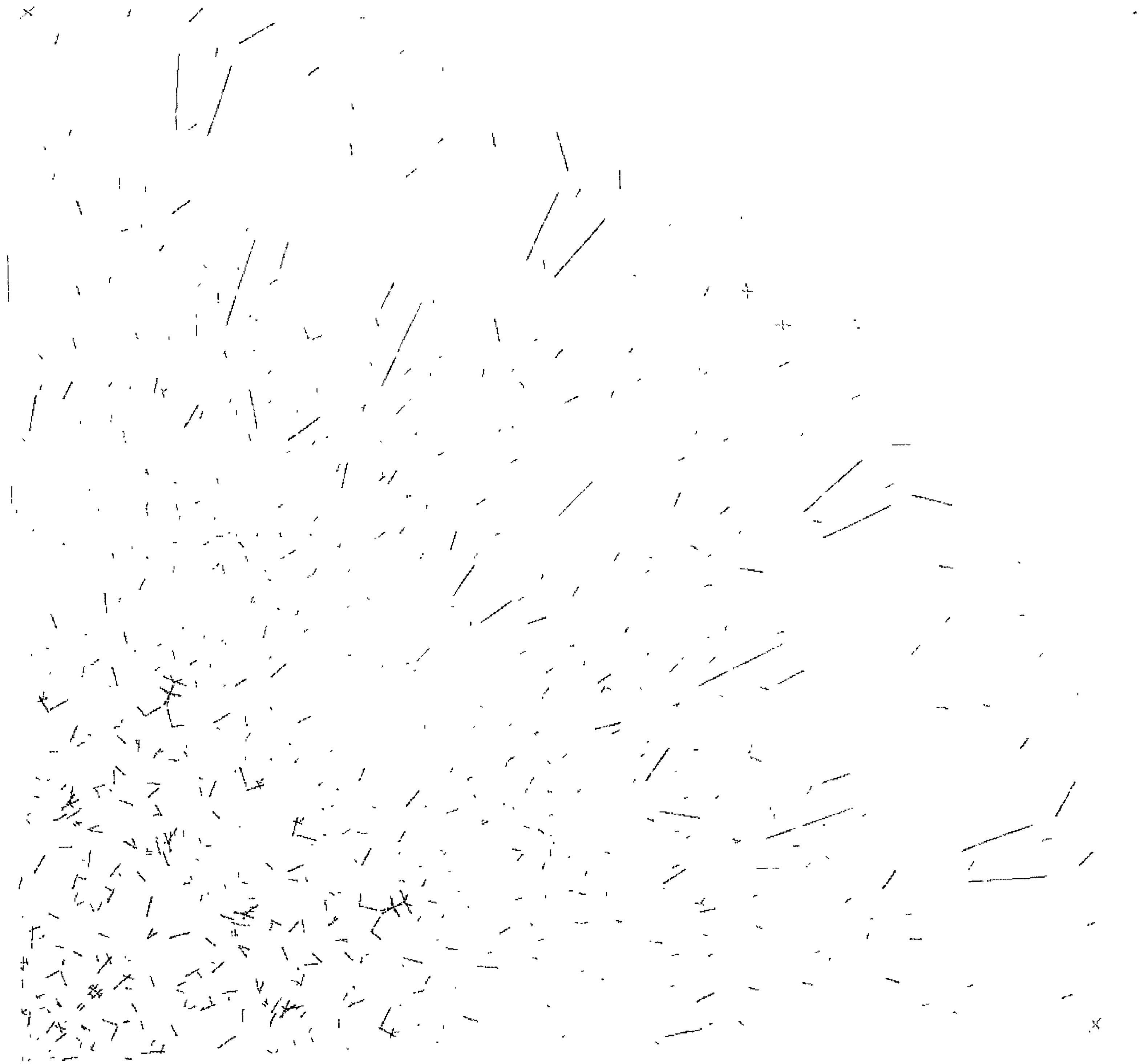


Fig 19

Fig 20

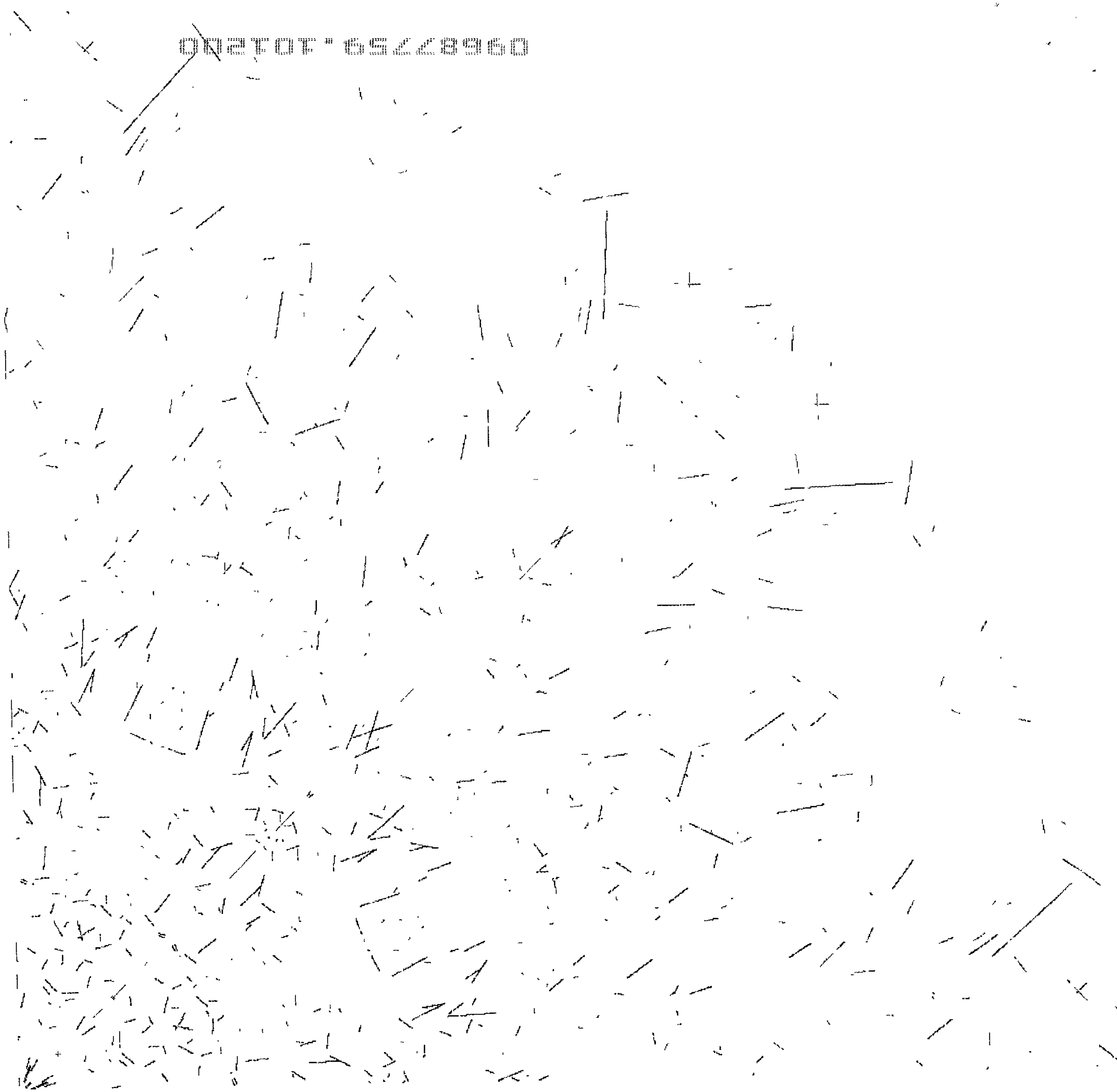


Fig21

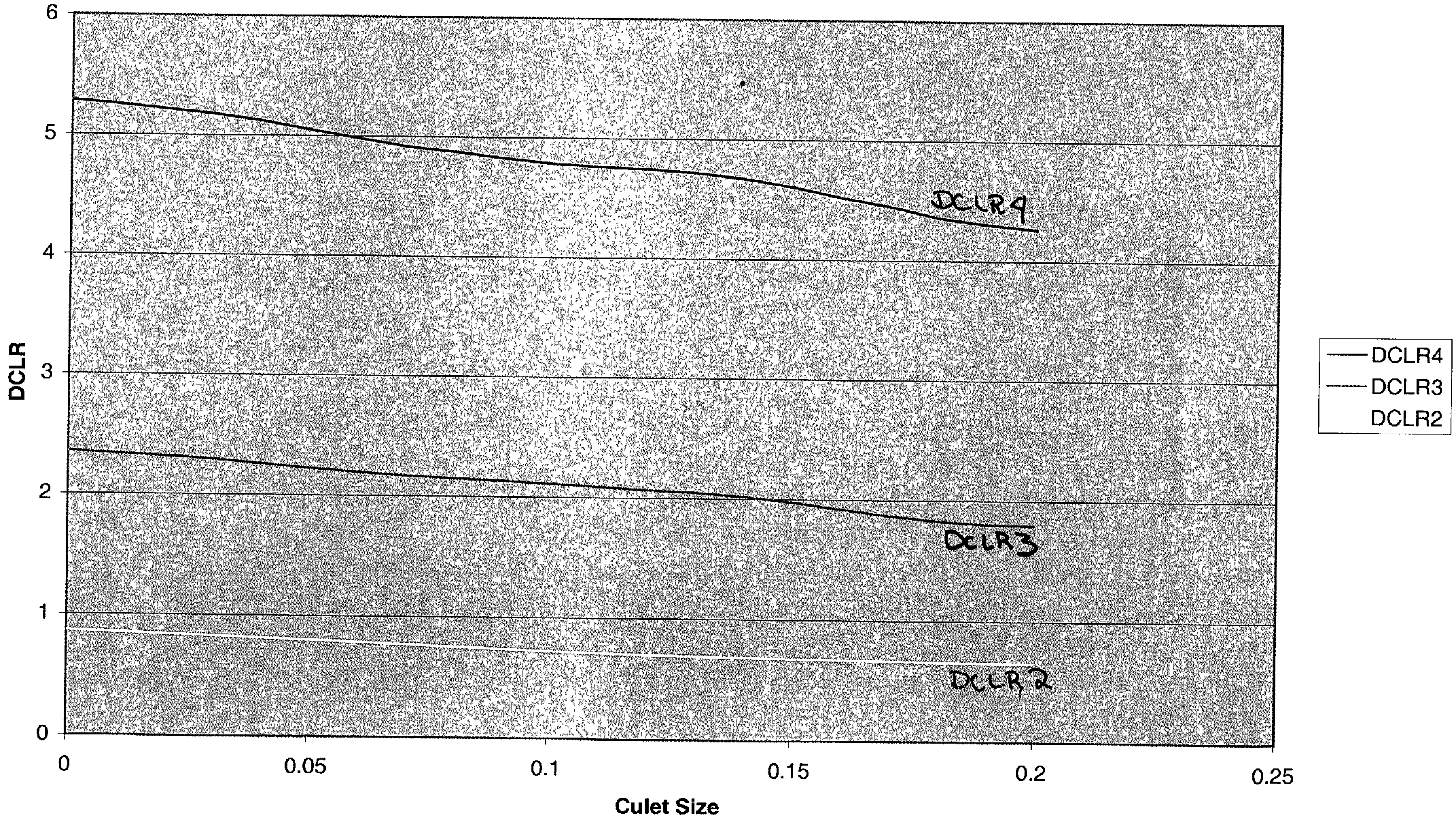
Fig 22

Fig. 23

		Table Size						DCLR 4		
34	40.5	0.45	0.005	0.5	0.75	0.03	64	6.282853	10	4
34	40.5	0.46	0.005	0.5	0.75	0.03	64	6.143581	10	4
34	40.5	0.47	0.005	0.5	0.75	0.03	64	6.036705	10	4
34	40.5	0.48	0.005	0.5	0.75	0.03	64	5.914933	10	4
34	40.5	0.49	0.005	0.5	0.75	0.03	64	5.823898	10	4
34	40.5	0.5	0.005	0.5	0.75	0.03	64	5.744799	10	4
34	40.5	0.51	0.005	0.5	0.75	0.03	64	5.69719	10	4
34	40.5	0.52	0.005	0.5	0.75	0.03	64	5.719851	10	4
34	40.5	0.53	0.005	0.5	0.75	0.03	64	5.667448	10	4
34	40.5	0.54	0.005	0.5	0.75	0.03	64	5.599147	10	4
34	40.5	0.55	0.005	0.5	0.75	0.03	64	5.428893	10	4
34	40.5	0.56	0.005	0.5	0.75	0.03	64	5.266954	10	4
34	40.5	0.57	0.005	0.5	0.75	0.03	64	5.037557	10	4
34	40.5	0.58	0.005	0.5	0.75	0.03	64	4.934068	10	4
34	40.5	0.59	0.005	0.5	0.75	0.03	64	4.934716	10	4
34	40.5	0.6	0.005	0.5	0.75	0.03	64	4.923382	10	4
34	40.5	0.61	0.005	0.5	0.75	0.03	64	4.922016	10	4
34	40.5	0.62	0.005	0.5	0.75	0.03	64	4.819245	10	4
34	40.5	0.63	0.005	0.5	0.75	0.03	64	4.80074	10	4
34	40.5	0.64	0.005	0.5	0.75	0.03	64	4.76932	10	4
34	40.5	0.65	0.005	0.5	0.75	0.03	64	4.686667	10	4
34	40.5	0.66	0.005	0.5	0.75	0.03	64	4.56382	10	4
34	40.5	0.67	0.005	0.5	0.75	0.03	64	4.486941	10	4
34	40.5	0.68	0.005	0.5	0.75	0.03	64	4.509926	10	4
34	40.5	0.69	0.005	0.5	0.75	0.03	64	4.57587	10	4
34	40.5	0.7	0.005	0.5	0.75	0.03	64	4.516473	10	4
34	40.5	0.71	0.005	0.5	0.75	0.03	64	4.50992	10	4
34	40.5	0.72	0.005	0.5	0.75	0.03	64	4.644815	10	4
34	40.5	0.73	0.005	0.5	0.75	0.03	64	4.482011	10	4
34	40.5	0.74	0.005	0.5	0.75	0.03	64	4.410741	10	4
34	40.5	0.75	0.005	0.5	0.75	0.03	64	4.096369	10	4

Fig. 24											
					LG			LG	DCLR4		
34	40.5	0.56	0.005	0.5	0.45	0.03	64	0.45	3.624814	10	4
34	40.5	0.56	0.005	0.5	0.5	0.03	64	0.5	3.768429	10	4
34	40.5	0.56	0.005	0.5	0.55	0.03	64	0.55	3.976636	10	4
34	40.5	0.56	0.005	0.5	0.6	0.03	64	0.6	4.319326	10	4
34	40.5	0.56	0.005	0.5	0.65	0.03	64	0.65	4.695213	10	4
34	40.5	0.56	0.005	0.5	0.7	0.03	64	0.7	4.955746	10	4
34	40.5	0.56	0.005	0.5	0.75	0.03	64	0.75	5.266954	10	4
34	40.5	0.56	0.005	0.5	0.8	0.03	64	0.8	5.418637	10	4
34	40.5	0.56	0.005	0.5	0.85	0.03	64	0.85	5.623973	10	4
34	40.5	0.56	0.005	0.5	0.9	0.03	64	0.9	5.607077	10	4
34	40.5	0.56	0.005	0.5	0.95	0.03	64	0.95	5.548603	10	4
								LG	DCLR 3		
34	40.5	0.56	0.005	0.5	0.45	0.03	64	0.45	1.70454	10	3
34	40.5	0.56	0.005	0.5	0.5	0.03	64	0.5	1.831406	10	3
34	40.5	0.56	0.005	0.5	0.55	0.03	64	0.55	1.874035	10	3
34	40.5	0.56	0.005	0.5	0.6	0.03	64	0.6	1.889197	10	3
34	40.5	0.56	0.005	0.5	0.65	0.03	64	0.65	2.057588	10	3
34	40.5	0.56	0.005	0.5	0.7	0.03	64	0.7	2.188972	10	3
34	40.5	0.56	0.005	0.5	0.75	0.03	64	0.75	2.345421	10	3
34	40.5	0.56	0.005	0.5	0.8	0.03	64	0.8	2.378217	10	3
34	40.5	0.56	0.005	0.5	0.85	0.03	64	0.85	2.365716	10	3
34	40.5	0.56	0.005	0.5	0.9	0.03	64	0.9	2.272546	10	3
34	40.5	0.56	0.005	0.5	0.95	0.03	64	0.95	2.09303	10	3
								LG	DCLR 2		
34	40.5	0.56	0.005	0.5	0.45	0.03	64	0.45	0.6471	10	2
34	40.5	0.56	0.005	0.5	0.5	0.03	64	0.5	0.677515	10	2
34	40.5	0.56	0.005	0.5	0.55	0.03	64	0.55	0.679215	10	2
34	40.5	0.56	0.005	0.5	0.6	0.03	64	0.6	0.690058	10	2
34	40.5	0.56	0.005	0.5	0.65	0.03	64	0.65	0.708702	10	2
34	40.5	0.56	0.005	0.5	0.7	0.03	64	0.7	0.781613	10	2
34	40.5	0.56	0.005	0.5	0.75	0.03	64	0.75	0.863241	10	2
34	40.5	0.56	0.005	0.5	0.8	0.03	64	0.8	0.905219	10	2
34	40.5	0.56	0.005	0.5	0.85	0.03	64	0.85	0.890675	10	2
34	40.5	0.56	0.005	0.5	0.9	0.03	64	0.9	0.85178	10	2
34	40.5	0.56	0.005	0.5	0.95	0.03	64	0.95	0.79999	10	2

Fig. 25
DCLR versus Culet Size



LA-165931

Fig. 26													
			Culet Size					Culet Size	DCLR4	DCLR3	DCLR2		
34	41	0.56	0	0.5	0.75	0.03	64	0	5.284192	2.355428	0.868906	10	4
34	41	0.56	0.01	0.5	0.75	0.03	64	0.01	5.25454	2.335876	0.857219	10	4
34	41	0.56	0.02	0.5	0.75	0.03	64	0.02	5.213373	2.316395	0.844447	10	4
34	41	0.56	0.03	0.5	0.75	0.03	64	0.03	5.174934	2.293616	0.830896	10	4
34	41	0.56	0.04	0.5	0.75	0.03	64	0.04	5.119718	2.258964	0.816658	10	4
34	41	0.56	0.05	0.5	0.75	0.03	64	0.05	5.046029	2.224922	0.802315	10	4
34	41	0.56	0.06	0.5	0.75	0.03	64	0.06	4.980114	2.194238	0.787939	10	4
34	41	0.56	0.07	0.5	0.75	0.03	64	0.07	4.915477	2.168457	0.772775	10	4
34	41	0.56	0.08	0.5	0.75	0.03	64	0.08	4.875271	2.149683	0.756819	10	4
34	41	0.56	0.09	0.5	0.75	0.03	64	0.09	4.826089	2.133423	0.740934	10	4
34	41	0.56	0.1	0.5	0.75	0.03	64	0.1	4.78476	2.111817	0.726574	10	4
34	41	0.56	0.11	0.5	0.75	0.03	64	0.11	4.761126	2.0903	0.713786	10	4
34	41	0.56	0.12	0.5	0.75	0.03	64	0.12	4.744847	2.065745	0.702585	10	4
34	41	0.56	0.13	0.5	0.75	0.03	64	0.13	4.717384	2.049073	0.693117	10	4
34	41	0.56	0.14	0.5	0.75	0.03	64	0.14	4.671139	2.018712	0.686312	10	4
34	41	0.56	0.15	0.5	0.75	0.03	64	0.15	4.604082	1.974939	0.680394	10	4
34	41	0.56	0.16	0.5	0.75	0.03	64	0.16	4.520027	1.921601	0.67369	10	4
34	41	0.56	0.17	0.5	0.75	0.03	64	0.17	4.449352	1.870071	0.667312	10	4
34	41	0.56	0.18	0.5	0.75	0.03	64	0.18	4.357821	1.830536	0.662123	10	4
34	41	0.56	0.19	0.5	0.75	0.03	64	0.19	4.306298	1.802996	0.656936	10	4
34	41	0.56	0.2	0.5	0.75	0.03	64	0.2	4.264232	1.795603	0.650633	10	4
									DCLR 3				
34	41	0.56	0	0.5	0.75	0.03	64	0	2.355428	10	3		
34	41	0.56	0.01	0.5	0.75	0.03	64	0.01	2.335876	10	3		
34	41	0.56	0.02	0.5	0.75	0.03	64	0.02	2.316395	10	3		
34	41	0.56	0.03	0.5	0.75	0.03	64	0.03	2.293616	10	3		
34	41	0.56	0.04	0.5	0.75	0.03	64	0.04	2.258964	10	3		
34	41	0.56	0.05	0.5	0.75	0.03	64	0.05	2.224922	10	3		
34	41	0.56	0.06	0.5	0.75	0.03	64	0.06	2.194238	10	3		
34	41	0.56	0.07	0.5	0.75	0.03	64	0.07	2.168457	10	3		
34	41	0.56	0.08	0.5	0.75	0.03	64	0.08	2.149683	10	3		
34	41	0.56	0.09	0.5	0.75	0.03	64	0.09	2.133423	10	3		
34	41	0.56	0.1	0.5	0.75	0.03	64	0.1	2.111817	10	3		
34	41	0.56	0.11	0.5	0.75	0.03	64	0.11	2.0903	10	3		
34	41	0.56	0.12	0.5	0.75	0.03	64	0.12	2.065745	10	3		
34	41	0.56	0.13	0.5	0.75	0.03	64	0.13	2.049073	10	3		
34	41	0.56	0.14	0.5	0.75	0.03	64	0.14	2.018712	10	3		
34	41	0.56	0.15	0.5	0.75	0.03	64	0.15	1.974939	10	3		
34	41	0.56	0.16	0.5	0.75	0.03	64	0.16	1.921601	10	3		
34	41	0.56	0.17	0.5	0.75	0.03	64	0.17	1.870071	10	3		
34	41	0.56	0.18	0.5	0.75	0.03	64	0.18	1.830536	10	3		
34	41	0.56	0.19	0.5	0.75	0.03	64	0.19	1.802996	10	3		
34	41	0.56	0.2	0.5	0.75	0.03	64	0.2	1.795603	10	3		
									DCLR 2				
34	41	0.56	0	0.5	0.75	0.03	64	0	0.868906	10	2		
34	41	0.56	0.01	0.5	0.75	0.03	64	0.01	0.857219	10	2		

34	41	0.56	0.02	0.5	0.75	0.03	64	0.02	0.844447	10	2		
34	41	0.56	0.03	0.5	0.75	0.03	64	0.03	0.830896	10	2		
34	41	0.56	0.04	0.5	0.75	0.03	64	0.04	0.816658	10	2		
34	41	0.56	0.05	0.5	0.75	0.03	64	0.05	0.802315	10	2		
34	41	0.56	0.06	0.5	0.75	0.03	64	0.06	0.787939	10	2		
34	41	0.56	0.07	0.5	0.75	0.03	64	0.07	0.772775	10	2		
34	41	0.56	0.08	0.5	0.75	0.03	64	0.08	0.756819	10	2		
34	41	0.56	0.09	0.5	0.75	0.03	64	0.09	0.740934	10	2		
34	41	0.56	0.1	0.5	0.75	0.03	64	0.1	0.726574	10	2		
34	41	0.56	0.11	0.5	0.75	0.03	64	0.11	0.713786	10	2		
34	41	0.56	0.12	0.5	0.75	0.03	64	0.12	0.702585	10	2		
34	41	0.56	0.13	0.5	0.75	0.03	64	0.13	0.693117	10	2		
34	41	0.56	0.14	0.5	0.75	0.03	64	0.14	0.686312	10	2		
34	41	0.56	0.15	0.5	0.75	0.03	64	0.15	0.680394	10	2		
34	41	0.56	0.16	0.5	0.75	0.03	64	0.16	0.67369	10	2		
34	41	0.56	0.17	0.5	0.75	0.03	64	0.17	0.667312	10	2		
34	41	0.56	0.18	0.5	0.75	0.03	64	0.18	0.662123	10	2		
34	41	0.56	0.19	0.5	0.75	0.03	64	0.19	0.656936	10	2		
34	41	0.56	0.2	0.5	0.75	0.03	64	0.2	0.650633	10	2		

United States Patent & Trademark Office

Office of Initial Patent Examination -- Scanning Division

SCANNED, #____

Application deficiencies were found during scanning:

☐ Page(s)__________ of ______________________________ were not present for scanning.
(Document title)

☐ Page(s)__________ of ______________________________ were not present for scanning.
(Document title)

☑ Scanned copy is best available. Drawings